IN TWO SECTIONS—SECTION ONE

MECHANICAL ENGINEERING

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This Month's Cover shows a picture of military tanks in action. It is used in connection with the leading article in this issue, "Mechanization of the Army."

MECHANICAL ENGINEERING

Volume 51 May, 1929 No. 5

Mechanization in the Army

An Authoritative Statement of the Development of the Experimental Mechanized Force of the U. S. Army, Contributed by the A.S.M.E. National Defense Division

WAR is naturally the time when armies make their greatest advances in principles and equipment, as it is only then that they can get first-hand experience and experimentation. In time of peace efforts are made to digest the experience of the last war and to try out new theories under conditions approximating warfare as much as possible. In doing this the development is necessarily affected to a greater or less degree by the personalities involved, the political situation, and the financial situation.

The World War was the greatest practical experiment in land warfare that mankind has ever seen. The lessons of that war are even now just reaching a codified form where they are materially affecting the organization and equipment of armies. The primary lesson learned from the World War was that the machine gun used on the defensive, and to a lesser degree other modern firearms, had to such an extent increased the casualties suffered by the attacking forces that warfare became largely immobilized and inconclusive. The heavy casualties involved necessitated for the offensive large reserves of man power, very complicated protective systems, and an enormous organization. This had the result of slowing down the movement of the offensive, largely eliminating the necessary elements of surprise and maneuver as well as requiring that the attacker have an enormous superiority in men and munitions.

The present U. S. plan does not contemplate the complete mechanization of the Army, but the organization of a self-contained, highly mobile offensive force of limited holding power, to act independently if necessary. Tanks are to be the backbone of the force, supported by a self-propelled artillery (guns on caterpillar mounts) and infantry armed with machine guns and semi-automatic weapons.

It may be that future work with the mechanized force will show it to be advantageous to mechanize our whole army, and it is highly advisable that the Army actively pursue the subject of mechanization and have the actual mechanized force as the nucleus for expansion in time of war.

Industry is mechanized; the Navy is mechanized; the Air corps is mechanized; even the home is mechanized today. Only the Army remains to be mechanized, and it is believed that the sooner this happens, the better it will be for our country.

The net result of the loss of mobility, of a partial loss of surprise, of the greater margin of men and munitions required for victory, and of the elimination of maneuver was to immobilize or stabilize the offensive. As an effective victory in land warfare is ordinarily won by maneuver in the form of a quick penetration, a flanking movement, or a surrounding or envelopment of the enemy, these forms of victory were no longer open to the attacker. The warfare therefore degenerated into one of attrition, or gradual wearing down, the victory going finally to the side which could keep up its replacements of men, material, and money the longer. Enormous quantities of lives and money were spent in trying to break this deadlock. But only insufficient and unimportant gains were made because the attacker did not have the enormous superiority required to overcome the great fire power of the defensive. It was only with our entry that the Allies gained the large superiority in men and munitions necessary to bring the World War to a close, and even then the Germans had been much reduced by attrition.

One major effect of this enlarging of the margin of men and material required for the successful offensive was that the roads in any given sector became insufficient for the movements of troops and the supplies required. This in itself was thus an added factor in reducing the mobility of the attacking forces.

The nations which had been involved in the warfare of attrition through two or three years of the war soon found that *the supply of men gave out before the supply of munitions.* We should remember that what the Allies requested most strongly of us in 1917 was men, specifically infantry. The nations thus affected, therefore, were naturally led to attempt anything which would augment fire power and save men. On the defensive this took the form of the much wider use of machine guns, as first exemplified by the Germans. On the offensive it took the form of the much greater use of artillery, both in the number of guns used and in the number of rounds fired. Statistics compiled by the French Army show that as the number of guns per man increased in their army, the number of French casualties decreased greatly.

Another important form which the attempt to save men took was the development of the tank. A tank is an automotive vehicle capable of traveling across country carrying various guns and their crew adequately protected by armor. The tank originated in England about 1915, being first used in battle in limited numbers in 1916. The French tank development started independently at a time somewhat later than the British. Sufficient battle experience with tanks was obtained during the World War to show that they are the logical answer to the question of reduction of casualties, of increasing fire power, and of increasing the mobility of the attacking forces. Referring to the last three months of the World War, Ludendorff said: "Mass attacks by tanks and artificial fog remained hereafter our most dangerous enemies."

Definitions

There has been much talk and some writing recently on the sub-

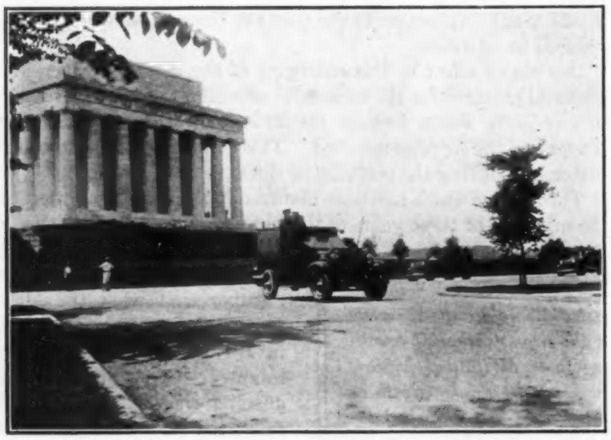
ject of motorization and mechanization of armies. To avoid confusion these terms should be distinguished by applying the definitions used by the War Department. "Mechanization" is defined to be:

> ...the application of mechanics directly to the combat soldier on the battlefield.

"Motorization" is defined to be:

> ...the substitution of the motor-propelled for the animal-drawn in the supply echelons of all branches of the army, and in providing increased strategical mobility for units of all types through the carrying of men, animals, and equipment in motor vehicles over roads.

Motorization of the army is being gradually achieved, and in time of war the extent of motorization would depend probably on two factors, namely, the availability of horses and the nature of the



First Armored-Car Troop (Cavalry)

country in which the warfare was being carried on. Mechanization, on the other hand, is not primarily a means of transporting the components of an army prior to combat, but signifies the use of machinery in actual battle to increase the mobility and fire power of the combat soldier, while at the same time reducing his vulnerability. The primary instrument of mechanization must therefore be a vehicle which is capable of traveling across country, which has high fire power, and which has protection for its personnel. *This means the tank in some form or another.*

The Necessity for Mechanization

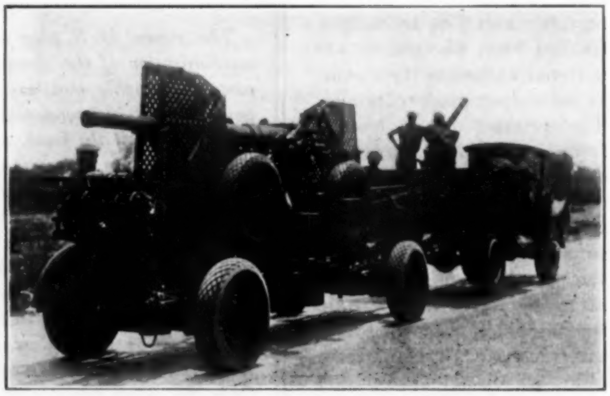
It can thus be seen that the necessity for mechanization arises primarily from the desire to restore to warfare that mobility and maneuverability of the offensive which is necessary to a decisive victory. In addition, mechanization is desirable to avoid a slow and costly victory possible only through human, industrial, economic, and moral attrition. From the standpoint of our country, mechanization is desirable because it gives to the most highly industrialized nation in the world a potential superiority which the non-industrial nations cannot approximate without changing their whole peace-time life and industry. This is because the success of mechanization in time of war will depend on the rapid and enormous production of the machines of war. As we look at the world today there are probably four nations that can achieve such war production, namely, the United States, Great Britain, France, and Germany, with ourselves safely in the lead.

The corollary to the necessity for mechanization is that it is a logical military development in keeping with the civil development of our country, as well as of the civilized world. Industry has long ago become mechanized and is becoming more so every day. The primary object is no doubt to cheapen the cost of production, but the not unimportant corollaries thereto are benefits to labor and a superior product. The profits to be achieved by mechanized warfare are (1) a great reduction in the number of casualties incurred in such wars as we cannot avoid; (2) a reduction in the length of such wars, resulting in a decreased cost of war, a shorter period of disorganization of commerce and industry and a more certain victory; and (3) a great increase in our potential military strength due to our industrial supremacy.

Foreign Mechanization

Great Britain has been the leader in the movement for mechanization. While this may look at first as if America were not "on the job," we must consider that the demand for mechanization in England has been greater than here because of the following factors:

1. England, during the last war fought to the point of exhaustion of her man power.
2. The World War was of such duration that England was impoverished and her world commerce greatly interfered with.
3. British democracy, like our own, will not maintain in time of peace a large standing army, which is the only logical alternative to a small mechanized army, and even then probably a poor alternative.



New Model 3-In. Anti-Aircraft Gun Mount

France has shown spasmodic interest in mechanization, but more as an auxiliary to her existing army than as a substitute for it. This may be largely accounted for by the fact that the research and development incident to mechanizing in time of peace is large and the financial situation of France has been bad. At the present stage of mechanized development it is therefore more economical for France to maintain a large conscript army, using the equipment left over from the World War, than to embark on a program of mechanization.

In Germany, limitations of the Versailles Treaty have prevented the Germans from having a large standing army of the prewar type. The material on hand during the World War has been largely destroyed. Germany has therefore concentrated on a small and highly efficient professional army. While Germany is prohibited by the terms of the peace treaty from building and owning tanks or other mechanized equipment, there are unmistakable indications that they are working hard on mechanization and are keenly interested in the subject. It has been rumored that actual experimentation is taking place by the building of tanks and other such equipment by Germans in friendly neighboring countries for the use of such countries.

THE BRITISH MECHANIZED FORCE

The British, who, as previously stated, have been the most active in mechanization, organized in 1927 an experimental mechanized force. This force was kept in continuous being until the fall of 1928, when it was disbanded, there being organized in place of it *two* new mechanized forces. This was done presumably with a view to having the two mechanized forces oppose each other in maneuvers. The British experimental mechanized force achieved a great deal of good in that not only the British Army, but all England, became immensely interested in the subject, and the whole matter was therefore thoroughly aired. Secondly, the British mechanized force was used in combat maneuvers against a non-mechanized or typical military force, in such a manner that the relative merits and demerits of the two types of forces were brought out.

A great many articles and books on the subject of mechanization have been published in England and are well worth reading to any person interested in this subject. Especially to be recommended are "The Remaking of Modern Armies," by Capt. Liddell Hart, and "On Future Warfare," by Col. J. F. C. Fuller. Colonel Fuller has been prominently identified with tanks and mechanization in the British Army since the birth of tanks in the World War.

THE AMERICAN E.M.F.

During 1927, when the British were experimenting with mechanization, the War Department General Staff was making an extended study of mechanization with reference to its usefulness to the American Army. A board was convened in the War Department which, as a result of its study, recommended in 1927 that an experimental mechanized force be assembled at Fort Leonard Wood, near Baltimore, in the summer of 1928. The total force consisted of about 1200 men and 400 vehicles of all kinds. Fort Leonard Wood, Md., where the tests were held, is the home of the Tank School and headquarters of the Tank Corps. The equipment for this mechanized force was gathered from Army stations all over the country and consisted of a wide variety of vehicles, both as to type and as to age. Almost the only new equipment available for this force consisted of four new light ($7^1/_2$-ton) tanks with a speed of twenty miles an hour, two cargo carriers built on the same chassis, two light armored cars, and four medium armored cars. Nearly all the other equipment had been procured during or right after the World War.

PORTÉE ARTILLERY

The Experimental Mechanized Force spent the early part of the summer getting organized and in preliminary training. This was followed by convoys or road marches by the whole force from Fort Leonard Wood to Upper Marlboro, Md., to Gettysburg, Pa., and to Tobyhanna, Pa. These marches were essentially strategic moves (or moves before battle), and were very valuable in bringing out the facts that most of the motor equipment with which the force was equipped was obsolete; and that large convoys of motor vehicles move more slowly than individual vehicles. However, a daily march by the whole force of 75 miles was seen to be a perfectly normal affair, and this is from *three to five times* the daily march that a similar military force, *not motorized* but muscle-propelled, could make. Right here we have one of the biggest advantages in mechanization, namely, that a mechanized force has a much greater mobility and therefore a much greater radius of action and a better chance of surprising the enemy.

MEDIUM ARMORED CAR

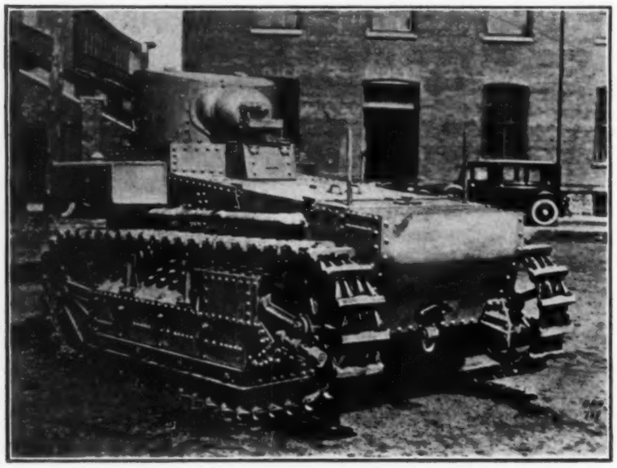
The last part of the summer was devoted to various combat maneuvers to determine the tactical uses of a mechanized force. For these problems the wheeled vehicles were used in the approach march, but with a few exceptions only the track-laying vehicles were used in the combat itself. The problems were limited in value by the fact that only six new fast light tanks (speed, 20 miles an hour) were available. Old 6-ton tanks and Mark VIII tanks, with speeds of five and six miles an hour, respectively, had to be used.

BASIC ELEMENTS OF A MECHANIZED FORCE

The basic elements of a mechanized force are tanks, airplanes, gas, and artillery. Artillery we have had as an integral part of armies for centuries, but it remained for Napoleon to bring out its great importance, epitomized in his remark to the effect that in war God was on the side that had the heaviest artillery. At the opening of the World War it soon became apparent that the proportion of the artillery to the infantry was inadequate, and there was a gradual increase in artillery throughout the war. Looked at broadly, artillery is only one form of mechanization, in that it *delivers into the enemy's territory a large destructive effect at a very small expenditure of human life.* However, there are indications that a period of diminishing returns has been reached in the employment of artillery. For example, Colonel Fuller states that at the third battle of Ypres, 4,283,550 shells were fired in the preliminary bombardment. This was equivalent in money to 17,134 tanks; and it may be left to the reader's imagination whether the tanks would not accomplish more than the shells. At the battle of Amiens, August 8, 1918, which Ludendorff called "the black day of the German Army," only 415 tanks were employed.

During the World War gas was introduced by the Germans. At first there were many outcries against the inhumanity of gas, and there are still many people who feel that way. However, as

Admiral Mahan once said, the question of humane weapons is almost ridiculous. Aside from that, gas is more humane than any other weapon because, while it incapacitates a great many men sufficiently to remove them from the battle and to make them a hindrance to their own army, the percentage that it kills or permanently disables is very small. Gas is therefore an important weapon in mechanization because (1) it can be produced in large quantities by an industrialized nation, and (2) it can be delivered against the enemy with a small expenditure of man power. Colonel Fuller quotes the reports of the Surgeon General, U. S. Army, to show that (in the A.E.F.) of 187,586 casualties due to



Light Tank T1E1

shells, bullets, or bayonets, the deaths were 46,449, or roughly 1 in 4. Out of 74,779 casualties due to gas, the deaths were 1400, or less than 1 in 50.

Aviation, as a weapon, may also be said to have had its birth in the World War. Discounting the superenthusiasts who would do away with everything but aviation, this weapon has in general the same big advantages that tanks, artillery, and gas have: namely, it delivers a powerful destructive effect against the enemy at a small expenditure of man power. In a mechanized force aviation would be used in the following missions:

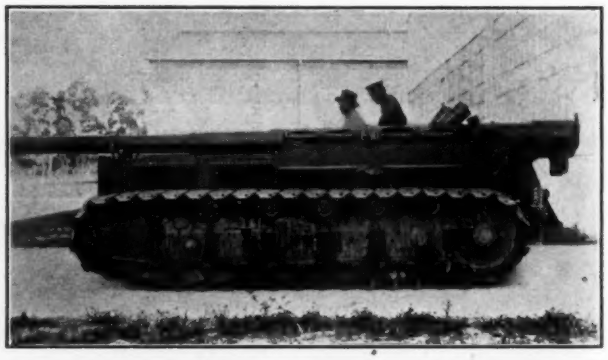
1 Observation and scouting
2 Laying smoke screens
3 Bombing
4 Attack of ground targets with machine guns.

The final but basic element of mechanization is the tank. This vehicle may be described as a vehicle running on caterpillar tracks and capable of transporting one or more guns and the necessary crew across any terrain with reasonable protection against rifle, machine-gun, and other fire.

The New American Light Tank Chassis

With a view to equipping a mechanized force the Ordnance Department designed in 1926 and has since developed and built (in 1927) a new light tank known as the Light Tank, T1E1. When fitted as a tank this vehicle weighs $7^1/_2$ tons, has a maximum speed of twenty miles per hour, is armored against ordinary rifle fire, has a crew of two men, and is equipped with a caliber .30 machine gun and a 37-mm. gun in a combination mount. (A 37-mm. gun fires a 1.25-lb. projectile containing high explosive.) This vehicle is about three times as fast as the standard 6-ton light tank with which our army is now equipped. The new tank has twice the fire power as it carries both a machine gun and a 37-mm. gun, whereas the old tank carries only one of the two. This vehicle has been an outstanding success not only in its speed and armament, but in its excellent mileage life and strategic mobility. It has run 2000 miles without a major overhaul, a remarkable performance for a fast track-laying machine. At the termination of the mechanized maneuvers at Fort Leonard Wood, five of these vehicles *ran on their tracks* from Fort Leonard Wood, Md., to Gettysburg, Pa., and return with no damage to the vehicles. The trip was made at an average speed of over ten miles per hour on the running time, and at a speed of over eight miles per hour on the elapsed time, which included all necessary halts. The distance to Gettysburg is 72 miles, and this was made in one day. This may not appear as a remarkable achievement to the general motorist, but it is the longest, fastest march ever made by any tanks in the United States. The speed is excellent when we consider that the Experimental Mechanized Force on its march to Gettysburg last summer averaged about $7^1/_2$ miles per hour on the same march over the same route, using only wheeled vehicles or trucks and motor cars. We have the best light tank in the world, but only five of them!

This tank march demonstrates that this tank has the necessary strategic mobility to keep up with a mechanized force. That is, it can go on long marches under its own power. However, due to the shorter mileage life of the track-laying vehicle as compared to a wheeled vehicle, tanks should not normally be operated for long distances on their tracks. It is uneconomical. The scheme that will probably finally be adopted will be to carry the light tanks on large commercial cargo trucks on roads and wherever practicable, reserving the *operation on tracks for the actual battle*



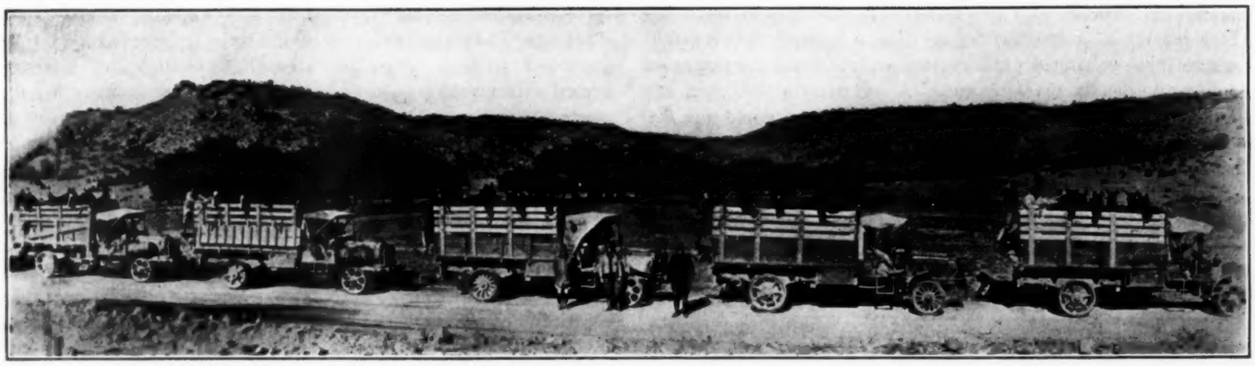
Self-Propelled Gun Mount for 150-Mm. Gun. Speed, 11 M.p.h.

and such other necessary instances as are imposed by the conditions of the campaign.

The new light tank has been so built that its chassis can be used as a universal chassis for mechanized warfare. That is, it can be equipped with a cargo body for a supply vehicle; as a carriage for a 75-mm. gun, (light field artillery); as a transport vehicle for telephone and radio equipment; and as a carrier for ammunition or engineer equipment. In fact, the idea is that the combat vehicles for a mechanized force will be built on this standard type of track-laying chassis, with variations in body and equipment built to suit the various needs. The use of such a universal chassis will reduce first costs, training difficulties, and maintenance problems.

Mission of a Mechanized Force

While the British seem to be tending toward the complete mechanization of their peace army, some of their authorities on the subject, like Capt. Liddell Hart, regard a mechanized force as the modern equivalent of independent cavalry, whose function it is to clinch the victory by mobility, surprise, maneuver, and



PORTÉE CAVALRY IN TEXAS

shock power while the main body of the army engages and holds the enemy. Whereas in the World War and afterward the tank was regarded as an *auxiliary* to the infantry, the tank is now the *basis* of the mechanized force, a land battleship. The mechanized force in our Army appears to be working toward the cavalry mission, having the functions mentioned but not the designation "cavalry." The tactical use of a mechanized force is still a hypothetical question, but it is believed that our Army is approaching the question correctly by experimenting first with a small force for special purposes.

This force will attack in waves of light tanks about 500 yd. apart, under cover of a smoke screen and supported by light self-propelled artillery. As the attack advances the artillery moves up in echelon, so that some barrage fire is maintained at all times. Heavier tanks will be used for special missions against certain strong points. The mechanized infantry armed with machine guns and automatic weapons moves forward behind the tank waves in special caterpillar infantry carriers, and consolidates the ground won until the position is taken over by the ordinary infantry, or holding unit. Whereas an infantry division in attack advances at the rate of less than one mile per hour, the mechanized force may be expected to advance at better than four miles per hour in battle.

ADVANTAGES AND DISADVANTAGES OF MECHANIZATION

The disadvantage of mechanization is:

High cost in time of peace, owing to the great cost of manufacturing special vehicles in small quantities and due to the rapid changes in the art.

The advantages of mechanization are:

1 *A saving of lives in war.* As an illustration of this we may take a naval battle. The Navy is an illustration of a fighting force that is almost completely mechanized. In the Battle of Jutland, the greatest naval battle there has ever been, the German losses amounted to about 2500 men and the British to about 5500 men. While the equipment involved was worth well over a billion dollars and the equipment lost ran into the hundreds of millions, the number of men lost was insignificant when compared to the land battles of the World War.

2 Mechanization gives an immense advantage to the highly industrialized nations; in fact, it almost puts the other nations out of the running. It thus limits major warfare to four or five large nations which should more easily be able to arrange the world peace between them.

3 Mechanization gives immense advantage to the United States, because we are the world's leading industrial nation, not only in facilities for manufacturing but in organization and in resources.

4 A successful army of the old type required a high degree of training not only in its officers but in its men. Considerable severe training and discipline are required of an infantryman before he will go into battle and perform his duty unflinchingly with an excellent prospect of being killed, and he must also know at the same time how to proceed to preserve his life in battle as long as possible. With mechanization the type of training required is largely mechanical and of such a nature that most of our citizen soldiers will already have had a fair share of it. Mechanization is therefore a distinct advantage to a country like our own, which maintains a small army in time of peace and must use mostly untrained soldiers in time of war. *Mechanization substitutes the destruction of material* (or equipment) *in war for the destruction of men.* In the World War it was found that the armies ran out of men before they ran out of munitions. In 1917, when the allies came to the United States for aid, their principal cry was for men, that is, *infantry*, which were being consumed at a frightful rate in the great battles.

5 In addition to saving lives, the economic value of which to the nation will not be computed here, mechanization has the advantage that it will bring a quick decision by maneuvers and fighting, rather than an indefinite decision (as in the World War) arrived at slowly by the wasting of the man power, the economic resources, and the moral stamina of the contending nations. As has so often been facetiously remarked, "The trouble with the Allies after the World War was that they had won the war, but lost everything else." This was due to the fact that the war dragged on until it was decided by the greater weakening of the moral and economic structure of the German Empire rather than by a clear-cut military victory over the Germans.

6 Mechanization in time of war will not be nearly so expensive as it appears in peace, because the vehicles and equipment used will be manufactured in enormous quantities. Tanks will take the place in battle of a considerable part of the enormous quantities of artillery ammunition formerly used.

7 The object of an army is to defeat the enemy by the use of

Unit	No. of men	Arms	Weight of fire, lb. per min.	Fire-power factor, lb. per min. per man engaged
Cavalry troop......	114	103 rifles, 7 pistols, 4 auto. rifles	44	0.39
Infantry rifle company............	256	235 rifles, 16 auto. rifles	105	0.41
Machine-gun company............	178	16 .30 cal. machine guns	197	1.10
Battery, 75-mm. guns............	199	4 75-mm.	520	2.60
Light tank company	112	24 37-mm., 24 .30 cal. machine guns	748	6.70

maneuver, surprise, and fire power. A mechanized force has these powers in a greater degree than a regular military unit because it is mechanically transported and mechanically protected against the deadly machine gun. A company of 250 men can be held up and almost annihilated by a machine gun firing 600 bullets per minute. The World War showed that it is suicide for the unarmored infantryman to attack the machine gun.

8 In addition to the reduction in casualties by the armor on the tank is the superior fire power of the tank company as compared with that of various army units. (See tables on p. 341, the last column of which shows the pounds of bullets and high explosive that can be fired against the enemy per minute per soldier risked in battle.)

Summing up, we find that mechanization gives:

1 Decreased casualties
2 Increased mobility
3 Increased fire power
4 Increased protection
5 Increased offensive or shock power
6 Advantage to U. S. over other countries
7 Less military training of the individual required
8 A quicker decision.

Present Status of Mechanization in the United States

The present status of mechanization in the United States is that the War Department Mechanization Board has made an exhaustive study of the results of last summer's work at Fort Leonard Wood. Based upon this study the Board has recommended the development and the gradual acquisition of the proper mechanized equipment for a mechanized force, the plan being to organize a small force in 1930, to be increased in size from year to year as funds become available. The present U. S. plan does not contemplate the complete mechanization of the army, but the organization of a self-contained, highly mobile offensive force of limited holding power, to act independently, if necessary. Tanks are to be the backbone of the force, supported by a self-propelled artillery (guns on caterpillar mounts) and infantry armed with machine guns and semi-automatic weapons. We already have a fine light tank and chassis for the combat vehicles of our mechanized force. Such a force is in the nature of a body of independent cavalry, which, while the main body of the army is holding the enemy, will determine the issue by a penetration and flanking movement, or the cutting off of the enemy's line of communication.

It may be that future work with the mechanized force will show it to be advantageous to mechanize our whole army. It is certainly not advisable to take this step at the present time, even if the money required were available. However, it is highly advisable that the Army actively pursue the subject of mechanization and have the actual mechanized force as the nucleus for expansion in time of war. Admiral Mahan, the great American writer on naval policy, once remarked:

> The student will observe that changes of tactics have not only taken place *after* changes in weapons, which necessarily is the case; but that the interval between such changes has been unduly long. This doubtless arises from the fact that an improvement of weapons is due to the energy of one or two men, while changes in tactics have to overcome the inertia of a conservative class; but it is a great evil. It can be remedied only by a candid recognition of each change.

We need a permanent mechanized force to work out the tactics of such a force, for the new weapons, particularly the tanks, are now in a practical stage.

Industry is mechanized; the Navy is mechanized; the Air Corps is mechanized; even the home is mechanized today. Only the Army remains to be mechanized, and, the sooner this happens the better it will be for our country. In this great work the A.S.M.E. National Defense Division recognizes an opportunity for patriotic service.

Taking Care of Depreciation and Obsolescence

By HAROLD V. COES,[1] NEW YORK, N. Y.

Webster defines depreciation as "the act or state of lessening worth." According to this definition all lessening of worth, whether due to age, wear and tear, lack of proper maintenance, decrepitude, inadequacy, or obsolescence, can be termed depreciation.

H. A. Foster, in "Engineering Valuation of Public Utilities and Factories," states that

> ....at the time of an appraisal all these forms of lessening value have to be given consideration as depreciation, but from an accounting standpoint, depreciation is only that deterioration of an object that cannot be made good by repairs, but requires a complete renewal. Obsolescence, inadequacy, and supersession, being speculative and prospective, play no part in this form of depreciation, and all other deterioration is to be made good by maintenance and is so charged on the books.

The Illinois Manufacturers' Costs Association makes this statement with regard to depreciation:

> Depreciation is due to possession and use; it is a decline in the value of all fixed assets—land excepted—and impairment of capital which is certain to occur as a result of deterioration through lapse of time, wear and tear, or obsolescence.
>
> The main purpose of the depreciation charge is not to show values on the balance sheet, but to apportion to the several accounting periods the net outlay of capital represented in the assets that are being depreciated. This actual charge may leave an amount having little relation to the physical valuation of the assets at a particular date and to one interested only in valuations the charge may seem a fiction, but successful business management has found it to be the only safe and sound principle to follow.

[1] Ford, Bacon & Davis, Inc. Mem. A.S.M.E.

Presented at the National Meeting of the A.S.M.E. Iron and Steel Division, Chicago, Ill., November 15, 1928.

Definitions

Brief definitions of some of the terms just referred to may help us to a clearer understanding of the subject.

Decrepitude. An article, building, equipment, tool, fixture, or the like may become so old, so worn, that new parts can no longer be retained in place by the original body, and hence the cost of maintenance becomes so high that it is cheaper to replace the article.

Supersession or Inadequacy. Foster defines this as "that lessening in value which takes place by reason of the growth of business, rendering apparatus inadequate for its purpose and compelling the installation of machinery capable of greater output or capacity."

Obsolescence. This is usually that lessening in worth which is brought about by developments, inventions, and changes in the art that render a plant, any part of its equipment, or whole sections of it, uneconomical of use as compared with newer types available of greater efficiency.

The "Century Dictionary" defines obsolescence as "going out

of use," which definition represents a falling off in the value of usefulness of a thing from causes outside of the thing itself as distinguished from the effect of wear or physical deterioration.

Wear and Tear. This form of depreciation and the one regularly recognized in accounting practice is that due to the elements, to abrasion, accidents, accelerated usage, and the like. Roofs can be repaired, glass replaced, new bearings installed, slides planed down, and bushings replaced; and such deterioration and its correction through replacement is usually charged to operating expenses. Experience has shown that where obsolescence has not set in or is operating, and the facilities are kept in reasonably good operating condition for the work that they are called upon to regularly perform, they are then maintained at from 80 per cent to 85 per cent of their original functioning condition. There are buildings in Europe that are in good condition, yet several hundred years old. We, all of us, have seen Corliss engines in operation over 50 years old. Some kinds of standard equipment, such as certain types of machine tools and textile equipment, are still good today, in many instances, for the purposes for which they are used, even though they may be 40 to 50 or more years old. Some of these facilities actually depreciate very little from age, use, and wear or tear, yet they have to be replaced on account of obsolescence rather than to decrepitude or to wear and tear.

The Federal Income Tax Regulations state:

> The necessity for a depreciation allowance arises from the fact that certain property used in the business gradually approaches a point where its usefulness is exhausted.... In the case of tangible property it applies to that which is subject to wear and tear, to decay, or decline from natural sources, to exhaustion and to obsolescence due to the normal progress of the art, as where machinery or other property must be replaced by a new invention, or due to the inadequacy of the property to the growing needs of the business....
>
> *Obsolescence.* With respect to physical property, the whole or any portion of which is clearly shown by the taxpayer as being affected by economic conditions that will result in its being abandoned at a future date, prior to the end of its normal useful life, so that depreciation deductions alone are insufficient to return the cost (or other basis) at the end of the economic term of usefulness, a reasonable deduction for obsolescence, in addition to depreciation, may be allowed in accordance with the facts obtaining with respect to each item of property....

Deterioration and Obsolescence the Two Prime Factors of Depreciation

Depreciation, then, is made up of two prime factors, deterioration and obsolescence, and they do not run concurrently in any given case, for whichever of the two is operating the faster, governs. A given type of standard machine tool may last 50 years at its present usage rate before it can be no longer commercially repaired. That would be depreciation at the rate of 2 per cent a year. It may, however, become obsolete two years after it is purchased for the purpose for which it was secured, and the rate, if such it can be called, would be 50 per cent a year.

No Accurate Rate of Depreciation Determinable

Accounting practice requires a rate for depreciation in order to show the depreciated value of the assets on the balance sheet and in the accounts of the business, and yet it is well recognized that there may not be any close connection, as stated by Dicksee, an accounting authority, between the intrinsic value of capital assets at any given moment and the depreciated value at which they appear in the books of account. Depreciation rates, however, are estimates only, and by the very nature of the many variable factors these rates must be set arbitrarily, so it can be said at the outset that there is no such thing as an accurate rate of depreciation. Climate, location, usage, care, promptness in the character of the repairs, the original quality of the article, and its condition at the time of acquisition, all have a bearing on the ultimate life, obsolescence excepted. These factors all compound in different proportions under given conditions. Since there is not a sufficient amount of data for any given article, under diverse conditions, to be able to treat the subject on an actuarial basis, the accrued depreciation must be the best estimate of those best qualified by experience and judgment to establish it.

Obsolescence is a form of depreciation that infrequently can be accurately estimated in advance of its definite occurrence. Confused thinking on the part of accountants, engineers, and the taxing bodies has rendered it difficult for executives to consider intelligently the problems incident to it, and to provide some means for financing those operations that are suddenly required by reason of the immediate occurrence of obsolescence.

The Illinois Manufacturers' Costs Association, in its pamphlet on depreciation, has this to say about obsolescence:

> Obsolescence is recognized as the most difficult element to determine, pertaining to the depreciation charge. In its determination, management not only has to make a guess as to the future of their own business, but as to what inventions will be made in the course of the next few years. However, past history teaches us that obsolescence has discarded more fixed assets than wear and tear.

They go on to comment on the practice of capitalizing obsolescence, and remark that the policy of capitalizing the unabsorbed depreciation of a superseded asset by adding this to the capital invested in the new facility, is not only unsound from an accounting viewpoint, but if persisted in will produce such an inflated investment in fixed assets that they will be carried on the books far above even replacement costs, in a period of higher prices. This must not be confused, however, with the case where an improvement and rehabilitation has been made of the existing facility that renders it of greater value for the purpose at hand than previously reposed in the reconditioned asset.

Causes of Obsolescence

Machines, equipment, methods, and processes become obsolete for many reasons:

1 An extensive change in the method of manufacture has developed
2 A substitution of materials is to be made
3 A substitution or consolidation of operations may be desirable
4 Newer machines of the latest type will produce the same part or piece more economically
5 A newer machine or method may reduce:
  a The hazard to the operator
  b The hazard of fire
6 To reduce waste and spoiled parts, more rigid and heavier equipment may permit heavier cuts or drafts and produce better finish or give greater required accuracy.

In certain cases it has been possible to go back and study the life history of a property, facility, or group of facilities, and determine when and how and over what periods obsolescence has been the governing factor of depreciation instead of deterioration, in the retirement of the property prior to the expiration of its estimated normal useful life. The studies are complicated and difficult to make, but are informative in formulating policies to provide for future contingencies. They are no guarantee, however, that similar conditions arising in the future will bring about the same results in the same periods.

When we realize that the railroads have spent nearly $3,500,000,000 in the period from 1922 to 1927 to improve their means and methods of transportation; that the automobile industry now produces 10 cars per man in the time formerly required for one; that in the steel industry two men do the unloading work of 12, 2 men the work of 14 in furnace charging, 7 the work of 60

in pig casting, and in the open-hearth operation one does the work of 40 and in pig-iron unloading 2 do the work of 120, as pointed out by Messrs. Simonds and Thompson in their book "The American Way to Prosperity," then we begin to comprehend the part that obsolescence has played and is still playing in the industrial drama.

Obsolescence, then, is the most troublesome factor in depreciation today, and is giving executives more concern than deterioration since it is not adequately provided for in most instances. The more progressive companies charge the deterioration factor of depreciation, either through machine-hour rates or the factory overhead, direct to the cost of the sales, and endeavor to secure in the price levels proper allowance for depreciation for every salable unit of product turned out and sold. This is not true, however, of the factor of obsolescence, since this, like a fire, to all intents and purposes, occurs without warning. To guard against a loss from this source (fire) we use fire insurance, where the risks are spread and the burden per individual lightened.

It is believed that it is entirely reasonable to assume that in the majority of cases, except in certain public utilities and a few isolated cases in industry, the price level is too low on the average to permit an adequate recovery of the assets wasted by reason of the factor of obsolescence. Now this is a serious menace to industry and to the future of industry in this country.

Two Sound Ways of Dealing With Obsolescence

How can we cope with this situation? There seem to the author to be two sound ways to deal with this problem, since it is patent that we cannot set up a rate for obsolescence in the majority of instances that means anything. These are:

1 Set aside from surplus net earnings a definite amount based on such past history and experience, and appraisement of the future, as best judgment in each case will permit, and actually create an obsolescence fund whose rate of upbuilding may vary from year to year, depending upon the business and the surrounding conditions—the fund not to be subject to dividend declaration except after a careful review of all factors affecting the immediate and future position of the company.

2 For industry to consider careful cooperation with the insurance underwriters with a view to working out a basis of insurance for obsolescence, just as for fire, spreading the risk and lightening the burden per individual.

In the first case we should be carrying our own obsolescence insurance; in the second case it would ultimately be done on a more scientific and equitable basis, and the cost of the premium would be included in the cost of sales. Admittedly, there are difficulties in working out obsolescence or placing it on an insurable basis, but it does not seem to the author that the problems presented are any more difficult or of greater magnitude than those which confronted the insurance underwriters when other risks and hazards were placed on an insurable basis.

The all-important thing for industrial executives to bear in mind is that no one is immune from obsolescence, and that furthermore the lack of a definite appreciation of this fact and a comprehension of what it may mean in the mere matter of economic existence, is responsible for price levels now too low to permit, in too many instances, an appropriation of surplus net profits to guard against this contingency. Some companies have a definite policy predicated upon estimated savings to be made by a new piece of equipment as compared with the old, of amortizing the cost of the equipment within a definite period out of the earnings. This again presupposes that the price level and the production are such, or will remain so, as to permit the estimated earnings and the amortization of the investment in the asset within the period contemplated.

It is estimated from the U. S. Treasury Department reports that there is invested in fixed assets in manufacturing industries in the United States, subject to depreciation, $16,000,000,000.

Excessive depreciation charges may so increase the cost of sales as to lose business on a competitive basis; on the other hand, the manufacturer who fails to adequately provide for depreciation and ignores it in his costs is likely to secure business on a competitive basis, but at the expense of the impairment of his stockholders' investment.

The Illinois Manufacturers' Costs Association states:

> At the present time the most disputed question regarding the depreciation charge is whether or not the purpose in providing for depreciation is to distribute the cost of the fixed assets (less salvage value) over their estimated useful and productive life, or to provide out of the earnings made during their estimated useful and productive life, capital to renew the depreciating assets on the basis of their replacement values, as these renewals become necessary.

Depreciation Should Be Cared for by Suitable Appropriations of Surplus or by Insurance

The author believes that it is sound practice to so apportion the depreciation charge as to recover through the current operating accounts the original investment in the asset, as and when the asset is replaced, and that it is more or less immaterial how this charge is determined, i.e., straight line, reducing balance, sinking fund, or other method, provided that it represents the facts as nearly as possible, and provided furthermore that fluctuations in value and the factor of obsolescence are cared for by suitable appropriations of surplus or by some form of insurance.

This means, then, that the variation in value at the time of replacement as compared with the original cost, due to the variation in the purchasing power of the dollar, as determined by valuation, would be cared for by an appropriation of surplus, specifically created for that purpose. During the period of high prices this appropriation would be larger, and, conversely, it would be lower during the low-price period of the business cycle.

Production With Standardized Units

HAVE those of us who are responsible for production about reached the limit in reducing costs and increasing output? Or have we become so accustomed to the present practice of using standard machine tools, single-purpose tools, or a grouping of the two, that we must be shaken out of our rut by some idea bordering on the revolutionary? What I have to propose is called the "unit continuous system of manufacture." It contemplates the assembling of standardized production units such as drilling, milling, or bordering heads on a frame or base in such a way that all of the operations on a part would be completed by the time it had reached the discharge end of the machine. The thought is not new—it was presented to English engineers in a technical-society paper some years ago.

The system has three steps or stages, of which the first is the development of the simple machine unit operated by push-button control. The second step is the application of automatic unit control for the timing and operating of the simple machine units of the first stage. The third and final stage is the installation of an automatic work-moving unit to replace the manual handling incident to the operation of the first stage, or the first and second stages together, without it.

One such installation is in operation in England, and at least one in the United States that works on much the same principle. The system, therefore, is entirely feasible. Is it sufficiently flexible? The answer to that question depends largely on how well standardized the units are, and on how adaptable to parts of various shapes the transfer mechanism is.—Herbert E. Taylor in *American Machinist*, January 3, 1929, pp. 3–5.

Handling Papers and Small Articles by Pneumatic Tubes

By JAMES WHITING,[1] PHILADELPHIA, PA.

Applications of pneumatic tubes comprise $1^{1}/_{4}$-in.-diameter tubes handling radio messages, telegrams, telephone toll tickets, etc.; $2^{1}/_{4}$-in. tubes for general message and utility service; 3-in. tubes for handling tools, small machine parts, samples, etc.; 4-in. tubes handling hot ingot test pieces, gunpowder, paint samples, etc.; 5-in. tubes in testing laboratories and railroad freight yards; 3-in. × 6-in. oval tubes for bank service in handling pass books and deposits, and in publishing houses for carrying copy and proofs, etc., and 4-in. × 7-in. oval tubes handling complete folios of correspondence, insurance policies, etc.

The tasks to which pneumatic tubes are applied are innumerable and form a list which includes every industry, and as added applications are made in the general business world, new ones become constantly apparent.

THE earliest record on the subject of pneumatic transmission is found in a paper presented to the Royal Society of London by Denis Papin in 1667, entitled "Double Pneumatic Pump." Papin's plan was to exhaust air from a long tube by two large cylinders. The tube was to contain a piston, to which a carrier was to be attached by a string.

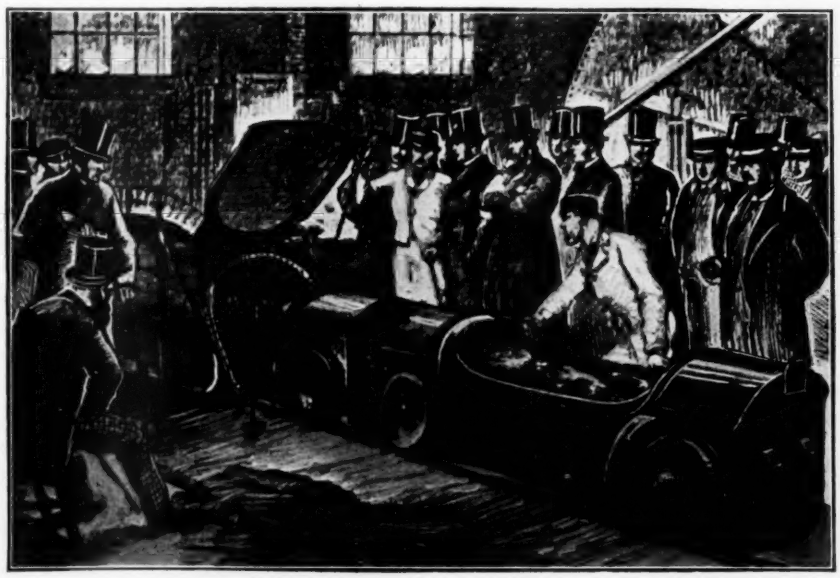


Fig. 1 Pneumatic-Dispatch Tunnel Constructed Between Euston Railway Station and the Central Post Office, London, in 1864

The first practical system of pneumatic transmission was installed by the Electric International Telegraph Company of London by their chief engineer, Josiah Latimer Clark. This system was installed in 1854 in the city of London between the main office of the telegraph company and the Stock Exchange, a distance of about 700 ft. The tubes were iron pipes $1^{1}/_{2}$ in. in diameter, and were operated in one direction only by vacuum maintained by a steam pump.

Four years later the same company, under the direction of their chief engineer at that time, C. F. Varley, increased the diameter of the tube to $2^{1}/_{4}$ in. and changed from iron pipe to lead tube. This line was operated in both directions, the outgoing by air pressure and the incoming by vacuum.

Paralleling the developments of tubes for transmitting papers, telegrams, etc., early inventors gave impetus to the art by attempting to transport material in bulk. The Pneumatic Dispatch Company of London under the direction of T. W. Rammell, in 1864, constructed a tube 4 ft. 6 in. by 4 ft. high connecting Euston Station with the General Post Office, in which carriages running on tracks were propelled at a speed of 17 miles per hour. These lines were operated by a fan 22 ft. in diameter which exhausted air from one tunnel and forced air into the other. A vacuum of 6 oz. per sq. in. was produced. This system was found too slow to transmit mail in bulk and its use was abandoned.

The firm of Siemens-Halske developed and installed a $2^{1}/_{2}$-in. system of telegraph tubes for the Prussian Government in Berlin. This system was gradually extended so that by 1872 the city of Berlin was provided with a network of tubes connecting the various sub-post offices and telegraph offices.

The French Government kept step with the development of the art, and by 1875 had connected 17 telegraph postal stations by tubes with the central office.

In 1867 Alfred E. Beach constructed a circular tunnel 8 ft. in diameter and about 200 ft. long in New York City under Broadway near Warren Street, and operated a car seating 10 people. The car was propelled alternately in one direction and then in the other, the motive power being pressure and vacuum obtained by changing the valves at the blower.

The Western Union Telegraph Company as early as 1876 laid four lines of tubes in New York City between their central office and four branch offices.

The application of small-diameter tubes for handling money and papers within buildings developed rapidly, and comprehensive installations to complete cash and charge transactions in retail department stores became quite common.

Pneumatic Transmission of Mails in Cities

Possibly the greatest forward step in the art of pneumatic transmission was made in 1892 when the first pneumatic-mail-tube system for the United States Post Office Department was designed and constructed by B. C. Batcheller, chief engineer of the Pneumatic Transit Company of Philadelphia, and a recognized authority on compressed air. This system consisted of a double line of $6^{1}/_{8}$-in.-inside-diameter tubes laid between the Central Post Office and the Bourse Sub-Post Office station, a

[1] Sales Engineer, The Lamson Company.

Contributed by the Materials Handling Division for presentation at the Rochester Meeting, Rochester, N. Y., May 13 to 16, 1929, of The American Society of Mechanical Engineers. Abridged.

distance of 2974 ft., in Philadelphia. This line was opened for the service of carrying United States mails on February 17, 1893, by Hon. John Wanamaker, then Postmaster General. The United States Post Office Department gradually extended this type of service in the metropolitan cities, increasing the diameter

FIG. 2 STANDARD 8-IN. U. S. MAIL CARRIER

FIG. 4 CARRIER FOR PAPERS

of the tubes from $6^{1}/_{8}$ in. to $8^{1}/_{8}$-in. Pneumatic mail-tube service ($8^{1}/_{8}$-in. double-tube lines) has been installed as follows:

Metropolitan New York	25 miles
Philadelphia	10 miles
Chicago	10 miles
Boston	6 miles
St. Louis	6 miles

The mail-tube service as laid out in the various cities provided a comprehensive scheme of expediting first-class mail, incoming and outgoing, between the railway terminals and the central post office, and between the central post office and the major sub-post-office stations.

The standard containers used in the 8-in. mail-tube service are formed of a seamless steel shell 24 in. long having an inside diameter of 7 in. (Fig. 2.) These containers will accommodate a package $20^{1}/_{2}$ in. long.

The shell is carried on two bearing rings $1^{3}/_{4}$ in. wide placed at equal distances from ends of the container and so located as to permit a carrier of maximum length to pass through a bend of minimum radius.

The bearing rings are made of alternate layers of cotton duck and rubber compressed and vulcanized to bone hardness. The outside diameter of the rings is $^{1}/_{32}$ in. less than the inside diameter of the tube. One set of bearing rings will give 12,000 miles of service before requiring replacement.

The forward or head end of the container is protected by a felt buffer reinforced by a steel stamping. The cover or lid of the container represents many years of endeavor to produce a foolproof positive-locking lid with safety features which would insure the locking of the cover and prevent the opening of the container while in transit through the tube, which latter might result in possible loss or damage to mail matter.

The empty containers weigh approximately 15 lb. and when fully loaded, 35 lb., and travel at a velocity of 30 ft. per sec. It is quite possible with the latest type of transmitters to dispatch carriers on a 7-sec. headway.

VARIED USES OF PNEUMATIC-TUBE TRANSMISSION IN INDUSTRIAL ESTABLISHMENTS

The extremely successful application of pneumatic-tube transmission to the handling of United States mails underground led to the use of tubes of smaller diameters, 3 in., 4 in., and 5 in., for what might be termed industrial service as compared to their widespread employment in retail department stores for cash-carrying purposes. The rapid growth of industry in recent years, necessitating large manufacturing acreage and scattered buildings, has given a further impetus to the application of pneumatic tubes in industrial plants for facilitating communication and manufacturing processes.

Applications of pneumatic tubes have been exceedingly diversified, as have also been the articles which the containers have carried. A demand has risen for pneumatic tubes in:

Steel mills, for handling test pieces between bessemer and open-hearth furnaces and the chemical laboratory.

Dye houses, for carrying samples of yarn from dye house to laboratory for matching as to shade and color.

Paint manufacturing, for carrying samples between grinder and laboratory.

Machine shops, for carrying light tools between tool room and shop department.

Plant offices, for carrying dictaphone records from departments to correspondence division.

Ammunition factories, for carrying powder from magazine to cartridge-filling rooms.

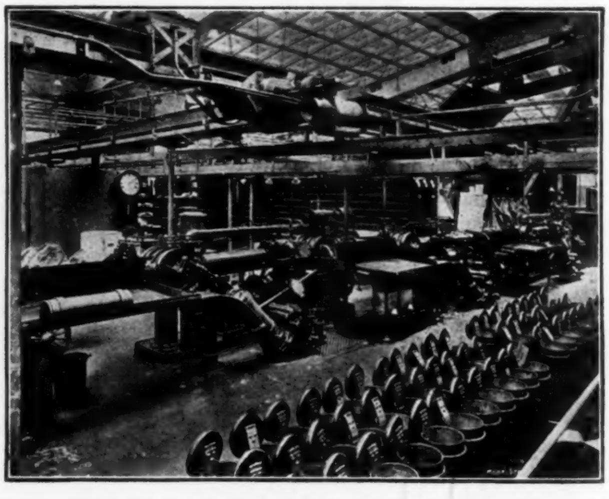


FIG. 3 TYPICAL ARRANGEMENT OF PNEUMATIC-TUBE TERMINALS IN A U. S. POST OFFICE STATION

Railroad terminals, for carrying baggage checks from baggage room to baggage master.

Custom House, for carrying jewelry and miscellaneous merchandise and documents from inspector to appraiser.

Railroad freight yards, for carrying car lists and conductors' reports to yard master.

FUNDAMENTALS OF CONTAINER DESIGN

The design of a container is naturally adapted to the article to be carried; if delicate objects, such as watches, samples of liquids, bottles, etc., protection must be provided for; if the material carried is at a high temperature, the container must be insulated; if its weight is considerable, strengthening of the container shell and buffer head must be resorted to; and if the article has a high value, locking devices for the lid end are essential. Terminal

design has followed along lines which permit rapid and accurately timed dispatches of containers and their quiet reception without undue force.

Applications of Pneumatic Tubes in Steel Mills and Railroad Yards

New and interesting developments in pneumatic-tube installation have resulted from the application of pneumatic tubes in steel mills and railroad yards. The length of tube lines in installations of this type are much longer in comparison with tube lines installed within buildings. The intermittent character of dispatch required to give normal service permits the use of a single transit tube for dispatching containers in both directions.

Pneumatic tubes in steel mills serve the purpose of rapid transmission of hot specimens weighing from one to three pounds between the blast-furnace, open-hearth, bessemer, and mill departments and the chemical laboratory. The report on the analysis of the ingot sent to the laboratory by tube is in turn forwarded by tubes to the respective departments.

The container velocity in tube lines of this character is from 35 to 40 ft. per sec. The tube lines are usually 4 in. in diameter and are operated by pressure in both directions.

The terminals are of the unit type, combining both the receiver and the transmitter. To insure the delivery of the carrier the terminals are equipped with electrically operated, definite time relays which control the flow of air for the time required for the carrier to be delivered from the tube. Where tube lines are not in excess of 200 ft. in length pneumatic time locks built integral with the terminals function as timing devices to control the air flow.

The containers accommodate test pieces 2 in. $\times$ 1$^3/_4$ in. $\times$ 5 in., each weighing approximately 2$^1/_2$ lb. They are made of heavy-gage seamless steel tubing with the bearing rings located at the extreme ends of the shell. These bearing rings are of vulcanized rubber and canvas, and are protected from the heat of the ingot by insulating disks of asbestos.

Fig. 5 Carrier with Indicator Designating Any Employee or Department

An idea of the service rendered by a pneumatic-tube line in a steel plant can be readily gained from a recent report from a steel mill in which it was stated that an average dispatch of 300 test pieces in 24 hours was made between the bessemer furnace and chemical laboratory.

The routes of the tube lines cross innumerable railroad tracks over which there is continuous movement of cars night and day, and this accentuates the necessity of mechanical messenger service.

The air supply for the operation of the tubes is generally obtained from the high-pressure-air-distribution service of the steel mill, which is stepped down by suitable reducing valves to the required operating pressure, this latter depending on the length of line.

The modern railroad freight classification yard with its length of four to five miles and its several widely separated points of major operation connecting with the main freight-yard office has offered excellent opportunities for application of pneumatic transmission. The layout of these yards is such as to give tube lines varying in length from 1000 ft. to 6000 ft.

The extreme lengths of tube lines, particularly with a single transit tube serving both directions of container travel, necessitated high carrier velocities, and consequent increased operating pressure, to expedite the mass of waybills, car lists, conductors reports, etc., required to be handled in a railroad classification freight yard in connection with the breaking up of a modern through freight train.

Ten years ago 2-in. I.D. tubes were installed and looked upon as a standard for railroad-yard installation. Today 5$^1/_4$-in. I.D. tubes with containers 20 in. long are necessary to accommodate the clerical matter required to properly break up and reassemble a through freight train of normal length.

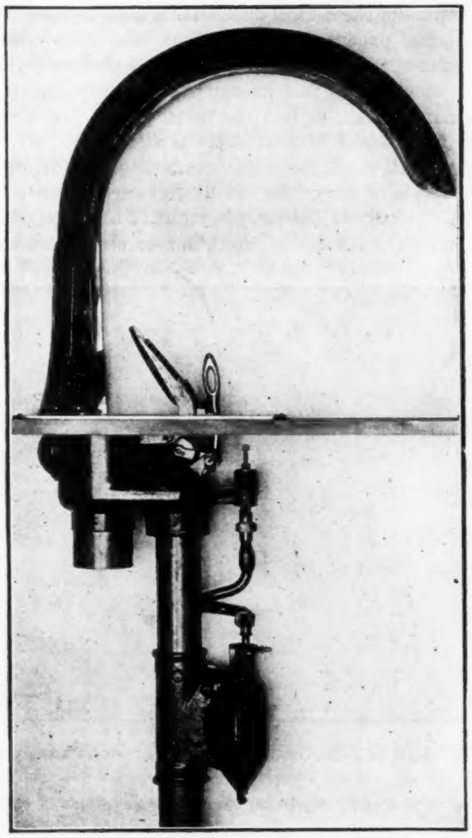


Fig. 6 Standard Up-Discharge 4-In. Single-Tube Pressure Terminal

The pneumatic tubes handle the inbound billing and check of inbound trains from the receiving yard to the main yard office; switch lists from main yard office to yardmaster and tower switchmen for switching cars into the classification yard on the proper tracks; side-car cards to be applied on cars to be switched over the hump; check lists of cars in classification and advance yards to main yard office; and outbound billing lists from main yard office to departure yard covering cars to connecting lines and terminal stations.

Container velocities of 45 ft. per sec. are demanded on some tube lines of this type, particularly the longer ones, in order to accelerate the dispatch of freight trains through the classification yards.

This application of pneumatic transmission in railroad yards has not only required the development of new types of dispatching and receiving terminals and containers, but field conditions have made necessary detailed investigation and tests for the purpose of developing non-corrosive tube; preventive measures against electrolysis; expansion joints for exposed

tubing providing a continuous guide for the containers; and means of eliminating condensation.

Pneumatic Transmission of Business Papers in Banks, Insurance, Company Offices, Etc.

A representative application of mechanical messenger service is that of pneumatic tubes in the modern-planned building housing the home office of an insurance company. A recent installation of this character embodied 50 stations placed at strategic locations in various departments throughout the building, connected to a central station by double lines of 4-in. × 7-in. pneumatic tubes.

The product of the clerical division of a life-insurance company is its policies, papers, communications, and interdepartmental correspondence. Expediting the production of these papers in an insurance company is just as important as production in any manufacturing plant, in fact the issuance and delivery of the policy to the insured without delay is vital.

This application of pneumatic transmission provides an excellent example of where the commodity carried has influenced the design not only of the container but of the tube itself. Insurance papers, policies, etc., must not be creased in handling, so an oval tube was found to be essential. The use of oval tubes necessitates for proper installation two kinds of terminal design, namely, flat and edge, depending on how the tube enters the substation.

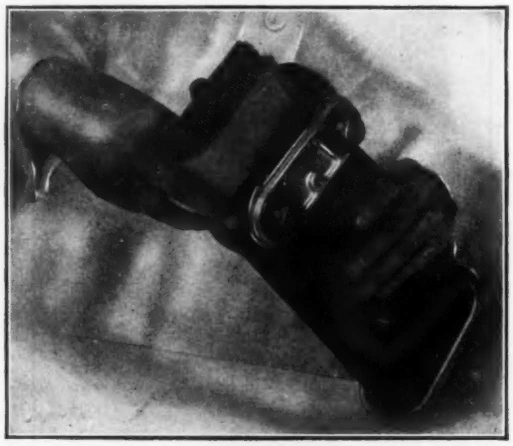


Fig. 7 4-In. × 7-In. Oval Carrier for Insurance Papers

The average length of the 4-in. × 7-in. carrier used by insurance companies is 14 in., and the average velocity through the tube is 30 ft. per sec. An analysis of a recent installation proved that a messenger force of at least 100 boys could not provide the service rendered by the pneumatic-tube installation of 50 stations. This calculation did not take into account the time of travel of the messenger except that consumed in waiting for and traveling by elevator.

A properly designed pneumatic-tube system is exceedingly flexible, and its applications are so numerous that it is well-nigh impossible to discuss in detail the varied and widespread uses.

The employment of pneumatic tubes in banks with the use of 3-in. × 6-in., 4-in., and 1½-in. systems which eliminate the hazards in handling securities between the tellers and the vault; which provide rapid and safe means of transferring collections, deposits, and pass books from the tellers to the proof cage, transit, and clearing-house departments; and the almost instantaneous dispatch and return of the doubtful check between the teller and bookkeeper provided by the 1½-in. pneumatic tube, represent an application in which enormous sums are invested annually by financial institutions.

Likewise, in the operation of the larger hotels a pneumatic-tube system links the floor clerks with the front office; the porter's desk with the front office; the cashier with the dining-room service, kitchen, and pantry departments; and the front office with the telegraph office, linen room, housekeeper, and various other departments. Tubes have become as necessary a feature in the modern hotel as telephone service.

Newspaper offices, competing for last-minute news items, have grasped the pneumatic-tube system to assist in satisfying public demand for the latest edition. Tubes between the editorial rooms and the linotype department, and from the want-ad. department to the composing room, have proved indispensable.

Fig. 8 Sending Medicine and Special Instructions From Dispensary to Any Part of Hospital

Hospitals with their ever-increasing area of building operation bring the dispensary in immediate contact with all wards and floors by means of tubes. Record charts of patients, files, prescriptions, diet notations, are rushed quietly to every department of the hospital by pneumatic transmission.

As if the applications on land were not sufficient, pneumatic tubes form a very important part of the communication service on board battleships. Duplicate systems of tubes on the port and starboard sides of the ship provide almost instantaneous communication of the written message between the auxiliary radio room and the main radio room, the conning tower, the flag officer's battle station, and the executive officer's station.

The scope of the application of pneumatic tubes is unlimited; its service value in speeding production is not yet determined and can hardly be visualized. Its forte is the acceleration of plant communications and production, with their consequent economic savings.

Heat-Insulation Practice in the Modern Steam-Generating Plant

By L. B. McMILLAN,[1] NEW YORK, N. Y.

This paper outlines briefly the engineering principles of heat-insulation design. Especial emphasis is given to the fact that the heat dissipated by so-called "radiation" losses is from the most valuable portion of the heat, and that these losses frequently result in the lowering of heat potential or temperature head, with a resulting loss in the value of all of the heat as measured by its remaining effectiveness.

A distinction is drawn between the cost of average heat and the value of a particular portion of the heat in terms of what it will accomplish in the way of useful results. The higher value of high-potential heat is demonstrated and a specific evaluation in the case of heat in superheated steam used for power generation shows that the high-potential increments of such heat may be 1-1/2 or even 2 times as valuable as the average heat content of the steam.

Results accomplished by the insulation of various units of power-plant equipment are discussed and typical installations are shown.

The factors involved in determining the most economical thickness of insulation are discussed and a chart is given on which each of the factors may be taken separately into account. The resulting economical thickness may be quickly and conveniently determined directly from the chart.

THE insistent demand for higher economies has resulted in the devoting of the greatest care to the design and operation of steam power plants in order that, for the conditions of the particular installation, the maximum overall economy will be secured. A marked feature of this development has been the advent of steam temperatures and pressures, which only ten years ago would have been considered highly speculative. But these and many other revolutionary improvements in power-plant design have proved highly successful, and along with them heat insulation, always an important item, has become a still more vital factor in power-plant economy. And insulation is no longer treated as merely an incidental, but is made the subject of careful engineering design, just as are the other items in the more complex power station of today. The object of this paper, therefore, is to point out some of the more important features of heat-insulation design and to present them in a manner conveniently useful to power engineers.

An outstanding feature of recent progress in the heat-insulation field has been the increasing realization of the fact that, large as they are, direct fuel economies are by no means the sum total of the beneficial effects secured by the minimizing of heat losses from heat-using equipment. In industry in general, greater attention is being given to the effect of insulation in increasing production through the maintenance of heat potential, in improving quality of product through the maintenance of greater uniformity of temperature, and in increasing the productivity of labor through the maintenance of improved working conditions in the vicinity of heated equipment.

Nor are these indirect effects lacking in the steam power plant. Results there may not be classifiable under the aforementioned three headings, but the insulation of pulverized-coal bunkers and piping to prevent caking of the coal due to condensation, and the insulation of turbine-room roofs, cold-air ducts, and condenser-water piping to prevent the troublesome drip due to condensation of moisture from the air are typical examples of cases where there are other considerations which completely overshadow that of heat saving.

The Higher Value of High-Potential Heat

The power station furnishes also one of the most convincing examples of the value of the maintenance of heat potential. The heat conserved by insulation is the most valuable portion of the heat. It is the cream, so to speak; the high-potential heat that costs most to produce and that does the most effective work.

Power engineers do not need to be told that a given number of B.t.u. at high potential will produce more power than the same number at lower potential; or that maintaining the required superheat will make all of the heat units more effective in the turbine than if dissipation of temperature head is permitted to degrade all of the heat; or that there is plenty of heat in the condensing water but useless because it lacks the required potential to make it capable of accomplishing useful work. But the attempt to evaluate the heat in terms of its potential is worth while, and seems not to have received the attention it deserves.

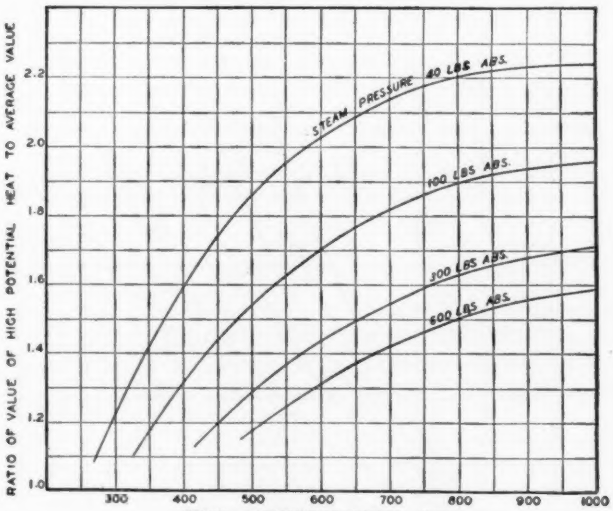


Fig. 1 Ratio of Value of Heat at Stated Temperature to Average Value
(Based on expansion to condenser pressure of 1 lb. abs.)

Fig. 1 represents the results of such an evaluation. It is at once apparent that in some cases the value of the last increment of heat at the top of a particular temperature range is between 50 per cent and 100 per cent greater than the average value for that range (the temperature range is that of the complete cycle from condenser temperature up to the given temperature). This is reasonable, because no extensive analysis is needed to show that the effectiveness of the last increment of heat in doing useful work must be much greater than the average when that average

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Note: Statements and opinions advanced in papers are to be understood as individual expressions of their authors, and not those of the Society.

is penalized by the low effectiveness of the first increments of heat added in the cycle to water at condenser temperature. The availability of these first increments of heat in the cycle to do useful work is but little above zero. Hence the average effectiveness must be lower than that of the last increment added at high potential.

Furthermore, it may not be said that the value ratios in Fig. 1 are only theoretical. They are very conservative and intensely practical. No claim is made that the high-potential increment of heat is converted into work at ideal efficiency, but surely the

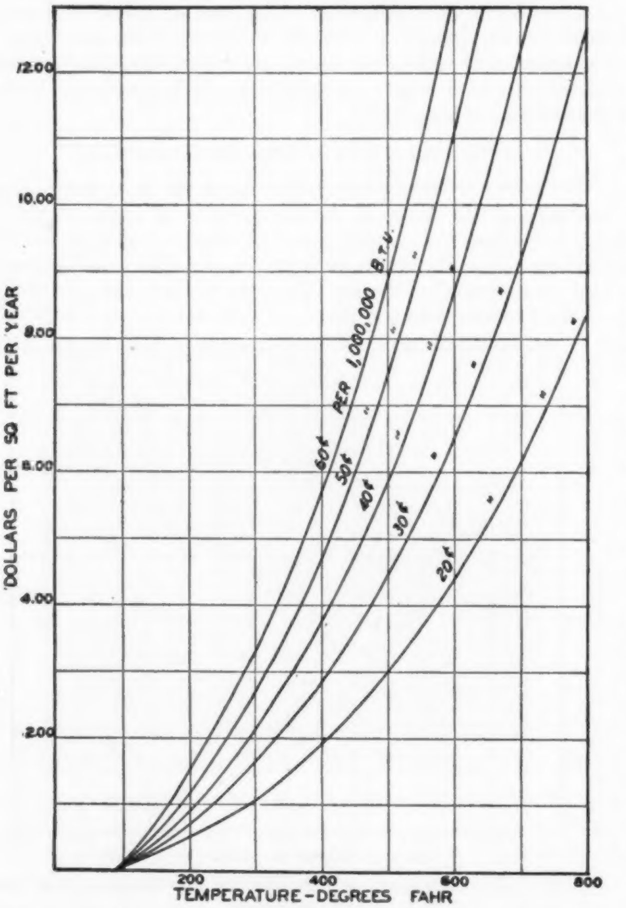

FIG. 2 ANNUAL COST OF HEAT LOSSES AT DIFFERENT VALUES OF HEAT PER 1,000,000 B.T.U.

inclusion of this increment *does not increase* nozzle losses, bucket losses, and windage. These items take a proportionately greater toll from the average than from the high-potential heat; therefore, for actual operating conditions the *ratios* in Fig. 1 are most conservative.

From Fig. 1 it will be noted that the relative value of the last increment as compared with the average value of heat decreases as the pressure is increased. This does not mean that the actual value of that increment is any less. It is the same, but since the average value of all of the heat is increased at the higher pressures, the ratio of value of the high-potential increment to the average is, of course, decreased.

It might be said that there is nothing new about this, and that the value of adding superheat to steam and of preventing excessive temperature drop has long been recognized. This is true, but temperature drop as such does not tell the whole story. It is commonly felt, if there are only a very few degrees drop from the superheater to the turbine, that the situation is satisfactory, and little thought is given to the dollar value of these few degrees when applied to literally billions of pounds of steam handled per year. When the dollar value is considered it usually is in terms of the fuel cost of the average and not of the high-potential heat. Yet it is this more valuable high-potential heat which figures in "radiation" losses—heat which would be available without further fuel cost, equipment cost, or operating cost.

COST OF HEAT LOSSES

In spite of the fact that it does not tell the whole story, a striking picture of the cost of heat losses from bare surfaces is obtainable by reference to Fig. 2. From this figure it is readily apparent that the loss from 1 sq. ft. of bare surface, at a temperature 300 deg. fahr. above room temperature and at a value of heat of 30 cents per 1,000,000 B.t.u., is $2.60 per year. Therefore 100 sq. ft. of such surface would lose $260 worth of heat a year. If the equipment is in use 7200 hours per year instead of 8760, the loss in spite of this reduced period of operation is still 7200/8760 = $214 per year for the 100-sq. ft. area. If the surface in question is on boiler drums, headers, pipe fittings, or other apparatus where the surface temperature of the metal is nearly the same as the inside temperature, insulation which will save more than 90 per cent of this loss may be applied at a cost considerably less than one year's savings.

Even if there are only a few square feet of surface at any one point, such as on bare boiler drum heads, pipe fittings, and flanges, the total loss from a number of such small areas may be startlingly large.

In the case of superheated-steam piping the extent of surfaces left bare is usually quite small, but, because of the higher temperatures and the greater value of the heat, the losses from such small areas may be much greater than would at first glance appear to be likely or possible. For example, the loss from one square foot of bare surface at 700 deg. fahr., and at a value of heat of 30 cents per 1,000,000 B.t.u., is $9.30 per year. If the steam pressure is 300 lb. abs., reference to Fig. 1 shows that the value of the high-potential increment of heat for power-generation purposes is 1.55 times the average value. Therefore the actual loss is $1.30 × 1.55 = $14.40 per sq. ft. per year.

The foregoing examples of losses and savings are based on still-air conditions. The effect of air circulation over a bare surface is to increase enormously the rate of heat loss An air velocity of 10 miles per hour will at least double the rate of loss from such surfaces. On the other hand, the losses from insulated surfaces, where the resistance to heat flow is mostly inherent in the insulation itself, are increased but slightly in proportion by air circulation. Where the increase in heat loss from a bare surface is of the order of 100 per cent the increase in loss from a well-insulated surface, with insulation tightly applied and thoroughly sealed so that air can circulate only over its surface, is of the order of less than 10 per cent. Therefore, where surfaces are exposed to air circulation the results accomplished by insulation are proportionately much greater than those illustrated.

TYPICAL INSULATION OF STEAM-PLANT EQUIPMENT

Piping. Steam is the finished product of the boiler plant. When it leaves the superheater outlet, or the boiler nozzle if only saturated steam is produced, it is a commodity against which all costs of production have been charged. Hence the desirability of delivering that product to the consumer with a minimum of loss en route has made the subject of pipe insulation a matter of primary interest since the early days of steam-power development. The progressively increasing steam temperatures and the increasing costs of fuels have added still further to the relative importance of this item of power-plant equipment.

Likewise these same factors have led to the substitution of rational engineering design for the empirical methods of selection formerly used. The matter of economical thickness of insulation has been made the subject of extensive investigation, and thicknesses are now chosen with assurance that they are really economical—that they are sufficient to provide adequate reduction in heat losses and yet not so thick as to necessitate unjustified first cost. And materials have been developed which may be used with the assurance that they will provide effective results at temperatures far beyond those of present-day steam-plant practice.

But the high-pressure and high-temperature-steam mains represent only a part of the entire piping system of a modern plant. Feedwater piping, auxiliary headers, water-wall circulation piping, connections from boiler nozzles to superheaters, soot-blower piping, drip piping, etc., constitute items less important per unit of area, but when total area is considered, become of major importance in the pipe-insulation problem. Even cold-water lines must be included among the classes of piping requiring insulation if troublesome drip from condensation of moisture from the air is to be avoided.

Preheated-Air Ducts. The preheating of the air used for combustion before admitting it to the furnace is a comparatively recent development, and, because of the fact that the heat in the air is usually recovered from what might otherwise be considered as waste heat, as, for example, the heat in the flue gases, it is often looked upon as having been obtained at little or no cost. But it does actually cost something. At least the fixed charges on the equipment required to recover the heat must be charged against it, and something more besides. But after all, *it is the value of the heat and not its cost that is important.* The major part of the cost has been expended when the equipment is put in, and that cost is incurred whether or not the heat is utilized after it is recovered.

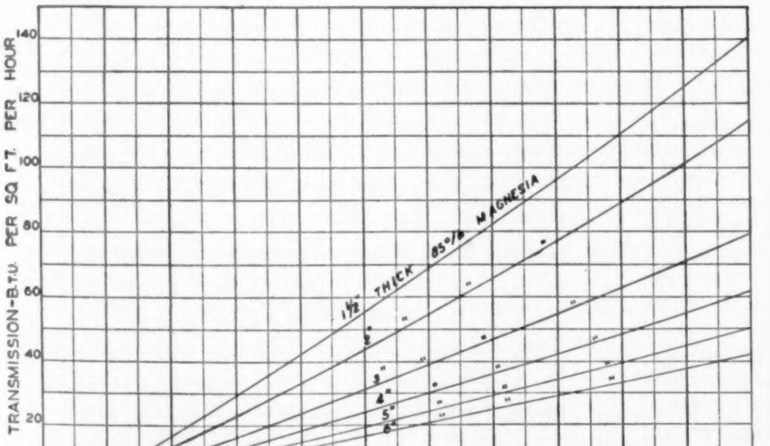

FIG. 3 HEAT TRANSMISSION THROUGH INSULATION ON FLAT SURFACES—TEMPERATURE RANGE UP TO 600 DEG. FAHR. (AIR TEMPERATURE, 80 DEG. FAHR.)

On the other hand, the *value* depends upon the extent to which the preheated air improves the entire process of steam generation. The installation is put in not only for the purpose of imparting to the air heat which it would otherwise have to receive in the furnace, but also to improve furnace and boiler efficiency because of the higher temperatures of combustion resulting from the use of preheated air. Therefore, at the very least, the value of the preheat in the air is not less than its equivalent in fuel. Actually it must be somewhat more than that. The true measure of the value of such heat is the cost of its replacement at the point of use. Or, more specifically, its value is equal to the cost of fuel required to replace its effect—the cost of the additional fuel required to produce a given quantity of steam, using air at lower temperature, over and above what would be required for the same production with air supplied at the higher temperature.

The function of insulation is, of course, to keep the heat in the air once it has been put there, and to maintain its effectiveness by

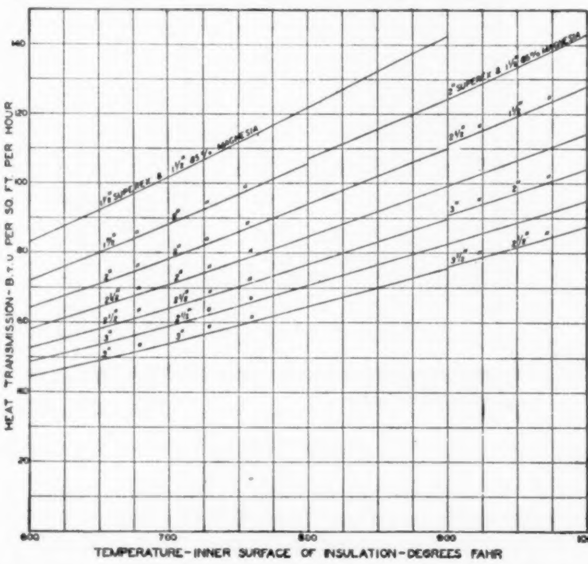

FIG. 4 HEAT TRANSMISSION THROUGH INSULATION ON FLAT SURFACES—TEMPERATURE RANGE 600 TO 1000 DEG. FAHR. (AIR TEMPERATURE, 80 DEG. FAHR.)

minimizing temperature drop in the air from the time it leaves the preheater until it is admitted to the furnace. The heat conserved is the most valuable portion of the heat content of the air. Again the importance of maintaining temperature head and the higher value of high potential heat are very apparent.

Figs. 3 and 4 show the heat losses which may be expected from various thicknesses of typical insulating materials. Fig. 3 applies to the temperature range up to 600 deg. fahr., and Fig. 4 to that from 600 to 1000 deg. fahr.

Boilers and Auxiliary Equipment. The practice in connection with the insulation of boiler drums, drum heads, other exposed portions of the boiler shell, feedwater heaters, and other auxiliary equipment is so thoroughly standardized that little attention need be given it here. A notable exception to this general statement is that adequate attention has not been given to the matter of minimizing the losses of heat from the tube headers of water-tube boilers. Perhaps the reason is that they are not considered as exposed surfaces because of the doors which shut them off from view. But these steel doors offer comparatively little resistance to heat flow, and, while the losses from the headers are not as great as if the doors were not there, they are still much greater than they need be. Lining the doors with suitable insulation provides resistance to heat flow many times as great as that of the air space between the headers and the doors; because, at the temperatures involved, large air spaces are very ineffective in limiting heat flow. The heat dissipated from the

tube headers is heat which has already undergone the process of being made available for steam generation. It is at the same potential, and if not lost would be of the same degree of usefulness as the heat in the saturated steam produced by the boiler. Its value is therefore just as great, and conservation at this point is a desirable step toward more economical operation.

The data on heat transmission through insulation, given in Fig. 3, for flat surfaces apply to boiler (not to boiler settings, of course) and auxiliary-equipment surfaces with a degree of accuracy sufficient for most engineering purposes, because the radii of curvature are usually quite large. If somewhat higher accuracy is required, this may be obtained by considering that the values from Fig. 3 apply to the mean area of the inner and outer surfaces of the insulation instead of to the actual area of the metal surface.

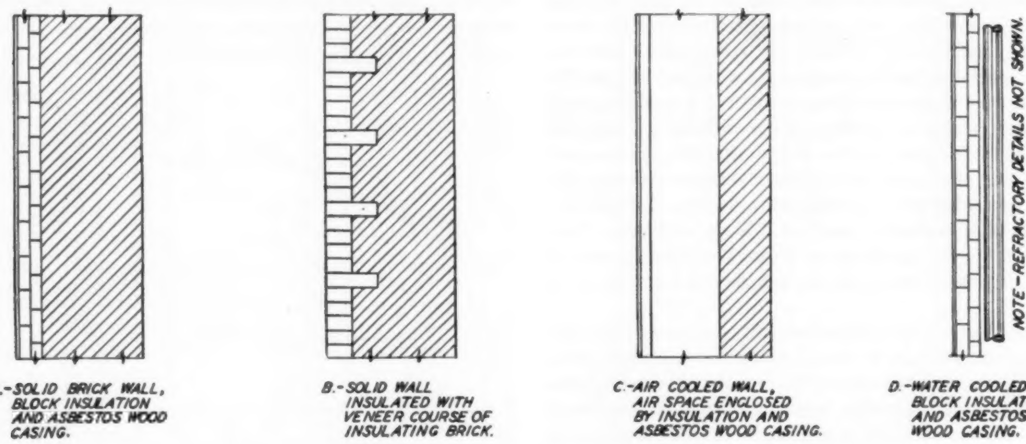

Fig. 5 Typical Sections of Four Modern Types of Boiler-Furnace Walls

Boiler Furnaces and Boiler Settings. The insulation of boiler settings and of the newer types of boiler furnaces are more recently developed fields which present many interesting problems and possibilities. In Fig. 5, typical sections of four modern types of boiler-furnace walls are illustrated diagrammatically. The sections are for the most part self-explanatory, except that in Fig. 5-D the detailed arrangement of the refractories around, between, or back of the tubes is not shown. There are a number of well-known types of water-cooled walls differing considerably in design, but so far as insulation is concerned the general principles governing its application are closely similar in practically all cases. First, the walls provide, in addition to the water tubes, some arrangement of refractories (cast iron would be considered a refractory in this sense) which protects the insulation from being subjected to the excessive temperatures that would penetrate between the tubes if such provision were not made. Then there is the insulation itself, and finally an outside protective and air-sealing finish for the insulation, which consists of asbestos wood, steel plate, or hard-finish insulating cement.

There are a number of designs of air-cooled walls, therefore Fig. 5-C is simply diagrammatic of the principles involved, and no attempt is made to show details of wall construction. However, in the main these walls consist of an inner refractory wall, a space or spaces for the circulating air, and an outer insulating casing. In general, the principles already discussed under preheated-air ducts, in connection with the value of retaining the heat in preheated air, apply also to air-cooled boiler-furnace walls.

There is still another type of insulated construction, not illustrated in Fig. 5, which is used with good results in the settings of smaller boilers of capacities up to 500 hp. This is the so-called "core-wall" type, where a course of insulating brick is used between a firebrick lining on the furnace side and a course of common brick on the outer side of the wall.

Results Accomplished by Insulation on Boiler Furnaces. The relative heat losses from solid refractory walls with and without insulation are shown in Fig. 6. The savings represented by the differences between the curves for insulated and uninsulated walls are very conservative since the conductivities of firebrick used in the computations were purposely taken in the low rather than the high portion of the range of firebrick conductivities. The values used range from 6.0 B.t.u. per square foot per degree temperature difference per inch of thickness per hour at a mean

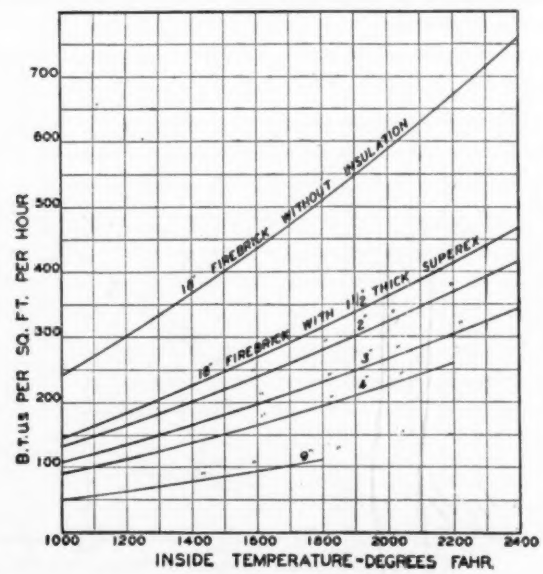

Fig. 6 Heat Transmission Through Insulated and Uninsulated Furnace Walls—18-In. Firebrick (Air Temperature, 80 Deg. Fahr.)

temperature of 1000 deg. fahr., to 8.77 B.t.u. at 2600 deg. fahr. mean temperature. Many investigators have shown conductivities at least 25 per cent higher than these, and higher conductivities of the firebrick would result in higher losses from uninsulated wall than those shown in Fig. 6. The losses through insulated walls would be increased somewhat by such higher firebrick conductivities, but to a much smaller extent; therefore, under such conditions the savings would be greater than those shown.

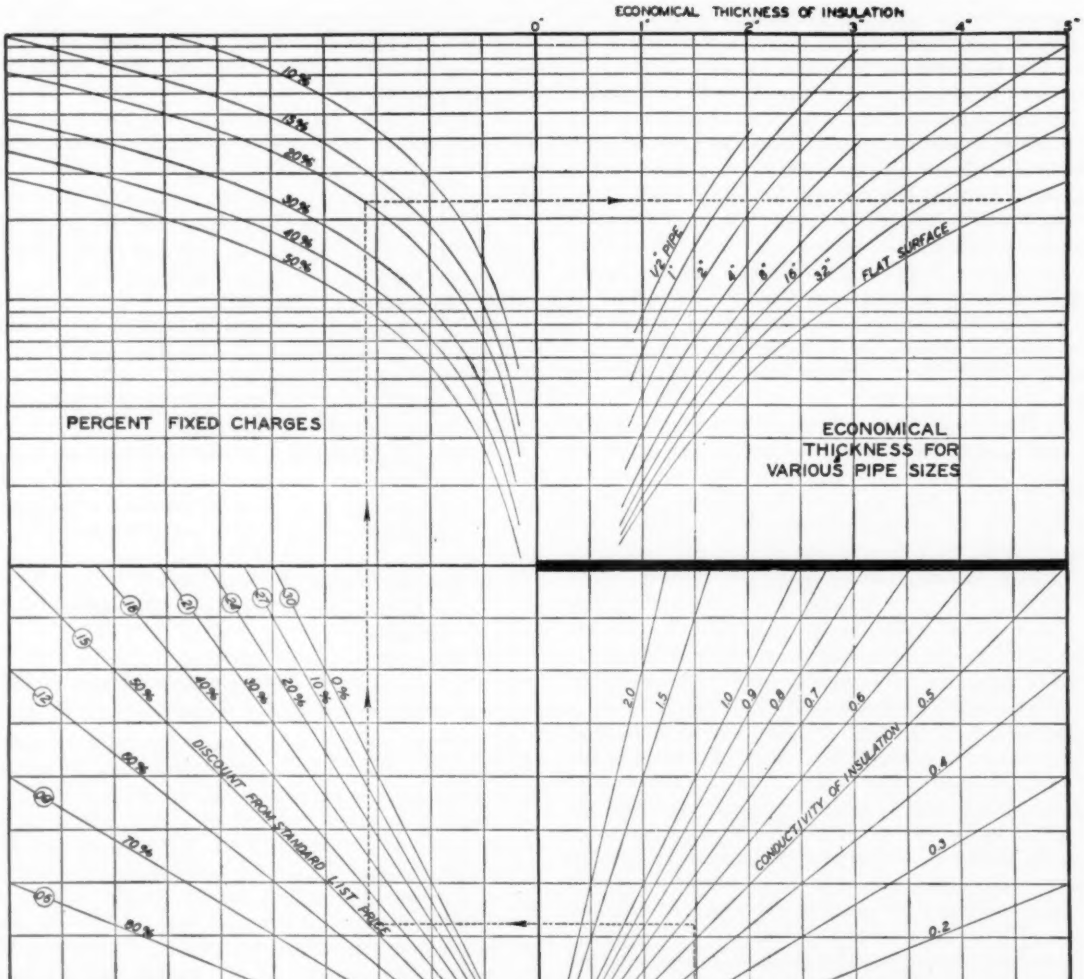

FIG. 7 CHART FOR DETERMINING ECONOMICAL THICKNESS OF INSULATION

Where insulating brick is used the thickness is usually $4^1/_2$ in., and the losses through walls insulated in this manner are closely approximated by the curve for 4-in.-thick block insulation.

Insulation may be applied in such manner as to minimize air infiltration as well as heat-transmission losses. Because of wide variations in their magnitudes on settings without insulation, it is not possible to evaluate as definitely the extent of air infiltration losses, but frequently the savings effected by insulation in reducing these losses is at least as great as those due to its effect in minimizing heat-transmission losses.

On both air-cooled walls and water walls the savings by insulation are proportionately much greater than on solid refractory walls, and a given thickness of insulation applied to either of these types of walls will bring the total loss down to a point far below what it would be if the same amount of insulation were applied on a solid refractory wall.

Breechings, Flues, and Stacks. Where there are no air preheaters or other means for utilizing the heat in the gases, the principal reason for insulating breechings and flues is to prevent excessive heating of the boiler room. There is also a corollary advantage, however, in the improvement of draft due to the minimizing of temperature drop in the gases before they reach the stack. Also, insulation is often placed inside of the breeching in order to provide a protective lining to guard the steel from corrosion. In many cases the insulation is used to serve the double purpose of protecting the steel and of conserving the heat content of the gases for utilization at some other point, as, e.g., in an industrial process requiring the use of such heat.

Where there are economizers or air preheaters or both, there are still greater advantages resulting from the insulation of uptakes and flues. In such cases the heat saved has a real dollar value, and the maintenance of temperature head increases the effectiveness of heat recovery in the economizer or air preheater. While the ducts or breechings carrying the spent gases from the recovery apparatus to the stack are at lower temperatures, and the value of the heat saved is a much smaller item, the very fact that they are at lower temperatures increases the tendency toward corrosion due to condensation of moisture on the steel, and increases the importance of insulating for the purpose of minimizing corrosion troubles.

Steel stacks are often provided with insulating linings for the purpose of protecting the steel from such corrosive action. Of course, in the case of stacks located in buildings there is a further very important requirement for insulation in order that overheating of spaces adjacent to the stacks may be avoided.

Economical Thickness of Insulation

When the decision has been reached that a given equipment should be insulated, the solution is not yet complete. The question remains as to how effectively it is to be insulated. Among the factors to be considered are, of course, the adaptability of the material to the conditions of temperature and usage to which it will be subjected, its durability, and the relative permanence with which it retains its initial insulating value. However, with these questions decided, there still remains the question as to what thickness would be most effective. Obviously, the greater the thickness the lower will be the heat loss, but as thickness is increased, fixed charges are also increased; therefore the thickness at which the sum of these two costs is a minimum is that which is most economical. At this point all of the insulation pays a satisfactory return on the investment represented by its cost. This is true even of the last increment of thickness, whereas the insulation as a whole may pay a return many times the required minimum.

In an earlier paper [Trans. A.S.M.E., vol. 48 (1926), pp. 1269–1318] the author presented a rational method of determining economical thicknesses of insulation. The chart Fig. 7 is based upon the equations developed in that paper, but it has been simplified in such a manner that the entire solution may be obtained graphically.

The principal factors involved in determining the economical thickness and the order in which they are taken into account are:

1 Hours of Operation per Year
(8760 hours for continuous operation)
2 Value of Heat in Dollars per 1,000,000 B.t.u.
(Not necessarily the average cost of heat, but its value at the given potential. See Fig. 1)
3 Temperature Difference
(Temperature of inside of equipment to be insulated minus temperature of surrounding air[2])
4 Conductivity of Insulation
(B.t.u. per square foot per degree temperature difference per 1 in. thick per hour)
5 Cost of Insulation, per cent discount from standard list
(Curves are also marked with respective costs per square foot 1 in. thick to provide for materials whose costs are not figured in terms of discount from standard list)
6 Per Cent Annual Fixed Charges
(Usually about 15 per cent in the classes of work under discussion)
7 Shape of Surface or Pipe Size
(Curves are given for cylindrical surfaces of various diameters and a curve is also shown for flat surfaces).

In order to use the chart, start at the lower left-hand corner and proceed to the right to a point representing the given number of *hours of operation per year;* then proceed vertically to the line representing the given *value of heat;* thence horizontally, to the right, to the line representing the given *temperature difference;* thence vertically to the line representing the *conductivity* of the given material; thence horizontally, to the left, to the line representing the given *discount* on that material (or given cost per square foot, board measure); thence vertically to the curve representing the required *per cent annual fixed charges;* thence horizontally, to the right, to the curve representing the given *shape;* thence vertically to the scale at the top of the sheet, where the *economical thickness* may be read off directly. The dotted line on the chart illustrates its use in solving a typical example. The actual thickness used will, of course, be the available commercial thickness nearest to the thickness as read from the chart.

[2] Where there is but little resistance to heat flow between the surface to be insulated and the source of heat, as in the case where the source of heat is steam, water, or rapidly moving gases on one side of a thin metal plate or pipe wall and insulation is to be applied directly to such surface, the resulting thickness read from the chart is at once the correct economical thickness.

However, it must be borne in mind that, if there is a considerable resistance to heat flow other than that offered by the insulation itself, as in the case of insulation on a brick furnace wall, correction must be made for the effect of such other resistances. For example, if the insulation is to be applied to a wall having a resistance of 2.0 $\left(\frac{\text{thickness}}{\text{conductivity}} = 2.0\right)$ and the conductivity of the insulation is 0.6 B.t.u. per sq. ft. per deg. temperature difference per 1 in. thick per hour, the correction which must be subtracted from the thickness obtained from the chart is $2.0 \times 0.6 = 1.2$ in.

The explanation of this correction is that the rational equations upon which the chart is based give the thickness of insulating material which would be required if there were no insulating value in the construction other than that offered by such material itself. If other resistances to heat flow are already present, naturally less additional insulating value will be required, and the correction simply involves deducting the thickness of insulation equivalent in insulating value to the resistances already present. (In the chart as plotted a deduction of 0.3 in. has already been made for outside surface resistance.)

Surface Heat Transmission

By R. H. Heilman,[1] Pittsburgh, Pa.

In view of the dearth of reliable data on the emissivity coefficients of various surfaces at the lower temperatures met with in refrigeration and heat-insulation work, the author undertook an investigation of the subject at Mellon Institute of Industrial Research, Pittsburgh. The complete paper describes that investigation, and among other things gives particulars regarding the methods employed in determining surface coefficients; the radiometer used; the determination of emissivity coefficients; derivation of an equation for convection; convection losses from various geometrical shapes; total heat loss from various shapes and surfaces, etc. Several charts are included in the paper which make it possible for the engineer readily to determine the total heat loss from various surfaces, and which eliminate all need for calculations for surface temperatures up to 700 deg. fahr.

A careful perusal of the existing literature indicates that there are few reliable data on the emissivity coefficients of various surfaces at the lower temperatures met with in refrigeration and heat-insulation work. However, a careful study has been made at Mellon Institute on the total transfer of heat from bare pipes. In this investigation the total surface transfer obtained from the experiments on the bare pipes has been separated into its two components, radiation and convection.

Tests have also been conducted on circular disks and on a long, thin ribbon in a vertical position. Knowing the relative amounts of radiation and convection from these various shapes, it is possible to derive formulas which will give the heat loss by convection as a function of geometrical shape, position, temperature, excess, etc. Having these formulas for convection from the various shapes, we can then determine accurately the total heat loss from any shape and for any type or nature of surface by adding to the convection loss the loss due to radiation from the well-known Stefan-Boltzmann law, and the emissivity of the various surfaces experimentally determined.

Method Used in Determining Surface Coefficients

The method used in this investigation to determine the emissivity factors for various surfaces is somewhat similar to the method used by Shakespear[2] in determining the black-body radiation constant.

The total rate of heat loss was measured under given temperature conditions for a lampblack-covered brass disk, heavily silver plated, containing an electric heating element, and later under the same conditions, except that the disk surface was highly polished. The difference between these two measurements gives the difference in radiation for lampblack and polished silver surfaces, since the convection is independent of the nature of the surface. At the same time the power measurements were taken the ratio of radiation from the lampblack surface to that of the highly polished silvered surface was obtained from the deflections of a sensitive radiometer. Having the difference in radiation from the power measurements and the ratio of the two radiations from the radiometer, we can solve for the absolute value of each.

At the same time we can calibrate the radiometer so that we can determine directly from the radiometer readings the actual losses by radiation from any surface to which the radiometer is exposed. This method of procedure allows us not only to determine the radiation loss or radiation coefficient from various surfaces, but enables us also to measure the amount of heat lost from the same surface by convection, so that we can accurately determine the convection losses for various surfaces as functions of temperature, geometrical shape, and position.

Description of Radiometer

The radiometers usually employed by physicists generally require considerable extra equipment when they are to be used for determining radiation over a considerable temperature range.

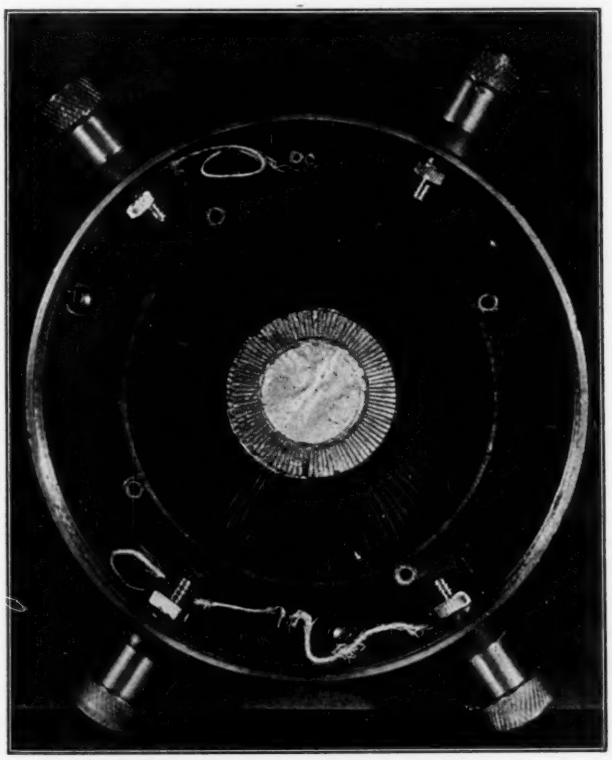

Fig. 1 Rear of Receiver

In order to keep the deflections of the galvanometer usually employed on the scale, it is necessary to employ various devices such as varying the distance of the radiometer from the radiation source, the use of shunts in the galvanometer circuit, or the employment of sectored disks to cut down the radiation, etc.

To eliminate these devices which have a tendency to cut down the accuracy of the measurements, the author has constructed a sensitive thermopile which can be used directly on a Leeds & Northrup Type K potentiometer, which latter is sensitive enough to give direct readings at temperatures below 100 deg. fahr. and to as high a temperature as is desired.

A full-size photograph of the rear side of the receiver is shown in Fig. 1, while the complete thermopile in its mounting with the radiation disk is shown in Fig. 2.

The receiver contains 96 thermojunctions of copper and con-

[1] Senior Industrial Fellow, Mellon Institute of Industrial Research, University of Pittsburgh. Assoc-Mem. A.S.M.E.

[2] Proc. Roy. Soc., London, vol. 86A (1912), p. 180.

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stantan wire, No. 44 B. & S. gage copper and No. 40 B. & S. gage constantan. The receiving disk consists of a sheet of tin approximately $^{7}/_{8}$ in. in diameter and 0.0005 in. thick, to the back of which is cemented with very thin shellac, 96 copper segments approximately 0.024 sq. in. in area and 0.0003 in. thick. The hot junctions were soldered to the copper segments with a very small, specially constructed soldering iron, the amount of solder deposited on each segment being extremely minute. The cold junctions were soldered to small brass pins contained in a circular micarta holder. In constructing this receiver the lightest materials obtainable were used in order to keep down the heat capacity. The copper to which the hot junctions were soldered was obtained by electrolytically depositing a very thin film of

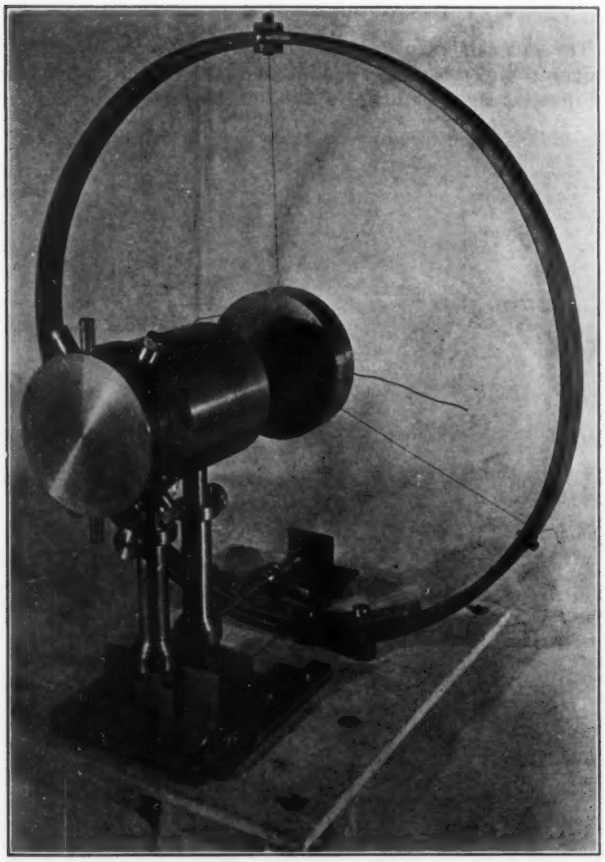

FIG. 2 THERMOPILE USED IN THE INVESTIGATION

copper on an aluminum sheet, after which the copper was stripped from the aluminum sheet.

The front side of the receiver was coated with a thin film of electrolytically precipitated platinum black, which produces a receiving surface having a very low reflection coefficient and a very high absorption coefficient.

When this receiver is placed at a distance of 3.75 in. from a radiation source of lampblack at a temperature of 300 deg. fahr., the e.m.f. generated by the receiver amounts to 5400 microvolts.

A copper-constantan thermocouple is soldered to one of the cold-junction pins, which enables one to determine at any time the temperature of the receiving disk.

DETERMINATION OF EMISSIVITY COEFFICIENTS

As mentioned previously, the method used in this investigation was to measure the total heat dissipated by two surfaces at the same temperature and also to determine the ratio of the radiations emitted from the surfaces. The theory of the determinations is somewhat as follows:

Let the radiator be lampblacked and maintained at temperature T_1 deg. abs.

If we expose this surface to the radiometer, the receiving surface of which consists of a platinum-blacked disk at temperature T_2 deg. abs., we shall get a certain deflection D_1.

Let R_{B1} be the energy radiated per hour from a unit area of the blackened radiator at temperature T_1 when exposed to the blackened cold surface of the receiver at temperature T_2, and let R_{B2} be the energy radiated per hour from a unit area of the blackened receiver at temperature T_2 to the hot blackened radiator at temperature T_1. Then $D_1 = M(R_{B1} - R_{B2})$, where M is a constant.

Now let the lampblack be removed from the radiator and let the surface of the radiator be polished, raised to temperature T_1, and exposed, as before, to the radiometer. Let the deflection be D_2. Then if R_{P1} be the energy radiated per hour from a unit area of the polished surface at T_1 to the blackened receiver at T_2,

$$D_2 = M(R_{P1} - R_{P2})$$

hence

$$\frac{D_1}{D_2} = \frac{R_{B1} - R_{B2}}{R_{P1} - R_{P2}}$$

Let

$$\frac{D_1}{D_2} = K$$

then

$$\frac{K-1}{K} = \frac{(R_{B1} - R_{B2}) - (R_{P1} - R_{P2})}{R_{B1} - R_{B2}}$$

Now, let C represent the combined conduction and convection losses per hour from the blackened radiator at temperature T_1, and H_{B1} the total loss of energy per hour from the blackened radiator at temperature T_1; then

$$H_{B1} = C + A(R_{B1} - R_{B2})(1 - b)$$

where A is the area of the radiating surface of the radiator and b is the reflection coefficient of the cold receiver.

In this case the factor $(1 - b)$ is almost negligible, as the reflection factor for platinum black is approximately 0.025 and the area of the receiver is very small in comparison with the area of the radiator. Test readings also confirm this assumption, as practically no change in temperature of the radiator could be detected when the radiometer was placed in front of the radiator.

Similarly, when the lampblack is removed and the radiator polished,

$$H_{P1} = C + A(R_{P1} - R_{P2})(1 - b)$$

Let

$$H_{B1} - H_{P1} = E$$

then

$$E = (1 - b)A\left\{(R_{B1} - R_{B2}) - (R_{P1} - R_{P2})\right\}$$

$$= (1 - b)A\frac{K-1}{K}(R_{B1} - R_{B2})$$

Let

$$(R_{B1} - R_{B2}) = a(T_1^4 - T_2^4)$$

then

$$E = (1 - b)A\frac{K-1}{K}a(T_1^4 - T_2^4)$$

so that

$$a = \frac{K}{K-1} \times \frac{E}{(1-b)A(T_1^4 - T_2^4)} \qquad [1]$$

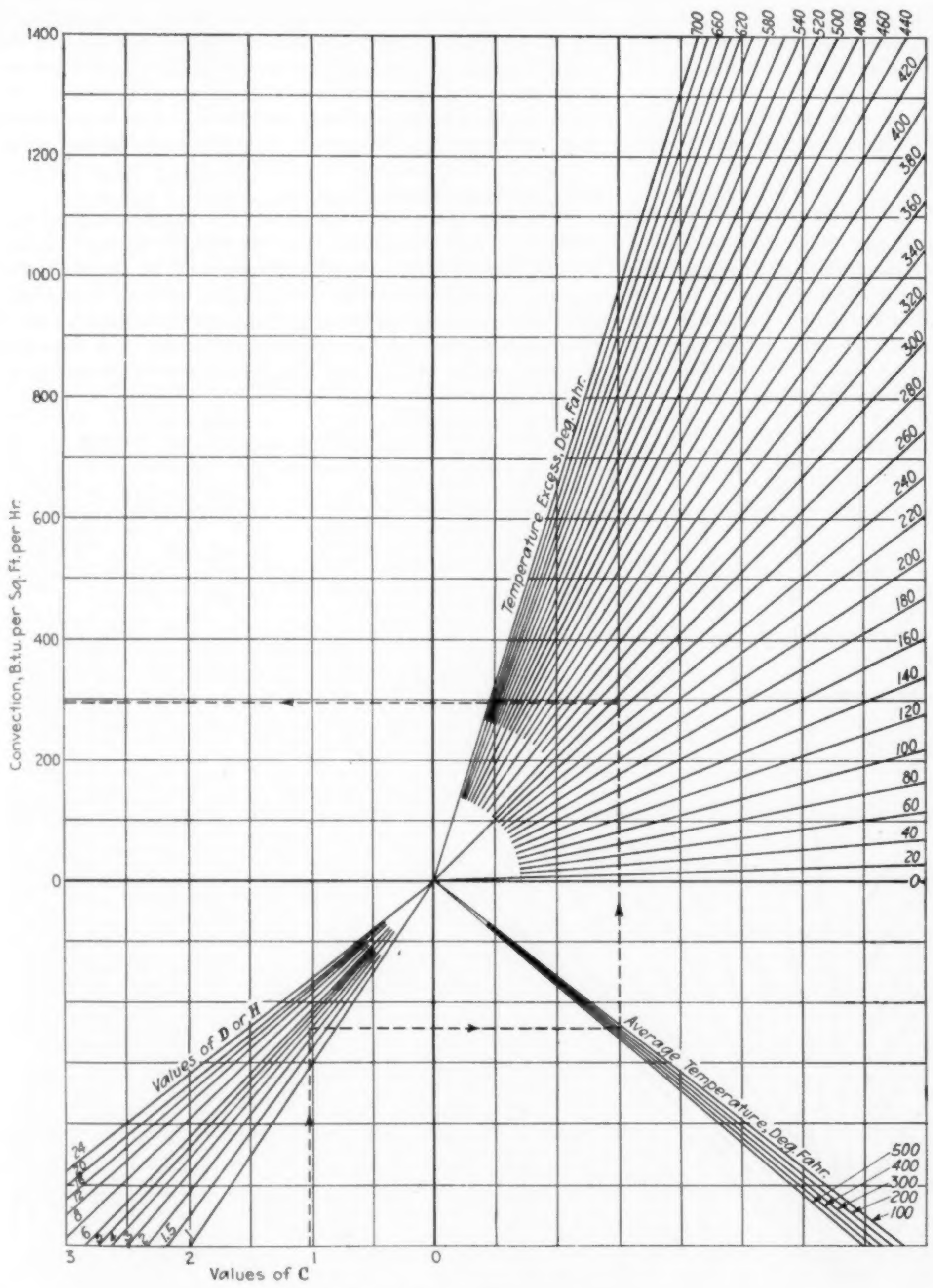

Fig. 3 Heat Transmitted by Convection

The use of lampblack on the radiator presents various difficulties in determining the constants of the radiometer. It is usually assumed by various investigators that the emissivity coefficient of a lampblack surface is approximately 98 per cent of that of a black body. However, it has been found during the course of this investigation that the emissivity of a lampblack surface varies considerably from 98 per cent of black-body radiation, especially when the lampblack is deposited over a polished silver surface. Values as low as 70 per cent and upward to 96 per cent have been obtained, depending upon the thickness of the lampblack deposited. It has been found that 40–50 microns thickness of lampblack is required on a polished metal surface to give an emissivity coefficient approaching that of a black body.

TABLE 1 EMISSIVITY VALUES FOR VARIOUS SURFACES

Surface	Temperature, deg. fahr. 100	200	300	400	500	600	700
Polished silver....	0.0221	0.0252	0.0292	0.0315	0.0295	0.0308	0.0312
Lampblack........	0.945	0.945	0.945	0.945	0.945	0.945	0.945
Asbestos paper....	0.930	0.934	0.943	0.955	0.929	0.938	0.943
Rough steel plate..	0.945	0.950	0.955	0.961	0.969	0.975	0.975
Aluminum-surfaced roofing..........	0.216	....	....	....	....	....	....
Polished brass.....	0.096	0.096	0.098	0.098	0.096	0.096	....
Flat black lacquer.	0.96	0.98	....	....	....	....	....
Black lacquer.....	0.80	0.95	....	....	....	....	....
White lacquer.....	0.80	0.95	....	....	....	....	....

It is very desirable when calibrating the instrument to calibrate it from surfaces having as high emissivity values as possible for the one surface and as low as possible for the other surface, and also to be able to determine the constants of the radiometer over the entire temperature range through which it is to be used. It has been found during the course of this investigation that the radiation from the surface of asbestos paper approaches very nearly that of a black body. The main objection to the use of asbestos paper is that the temperature range of the instrument cannot be carried as far as with lampblack. However, it is believed by the author that for lower-temperature work a thin sheet of asbestos paper can be used directly to calibrate a radiometer. For the benefit of future investigators who may wish to conduct radiation experiments, the emissivity factors as obtained during this investigation are given for asbestos paper for temperature ranges of 100 to 700 deg. fahr.

It has also been found that there are a great many materials used in engineering practice which have emissivity values very close to 98 per cent of black-body radiation, and it is believed that a great many of these surfaces could be used as standard radiators in preference to lampblack, which has been used almost entirely by former investigators.

The emissivity values for asbestos paper were determined in the same manner as those for lampblack, with the exception that the actual surface temperature of the asbestos paper, which was approximately 0.015 in. thick, was measured with a No. 40 B. & S. gage copper-constantan thermocouple fastened to the

asbestos surface with a thin strip of asbestos-paper tape. In this case, as also in the case of the lampblack, the increased area due to the thickness of the paper was corrected for in making the final calculations.

The emissivity values obtained for various surfaces, and the approximate values for 0.0028 in. thickness of lampblack on a polished surface are shown in Table 1.

Total Heat Loss From Various Shapes and Surfaces

From an extended discussion of the work of Rice, and of Griffith and Davis on convection losses from various geometrical shapes in the complete paper, as well as of his own work on heat loss from bare steel pipes, the author shows that the heat loss by free convection from the surfaces of the principal geometrical shapes met with in engineering practice can be approximated with great accuracy in most cases by the equation:

(other than lustrous or bright metallic surfaces) have practically the same emissivity value as was found for asbestos paper or the rough steel plate. Some of the surfaces included in this list are brick, stone, wood, plaster, paper, cloth, various colored paints, etc.

It should be mentioned here that these values are intended only for what might be termed "black" heat radiation, as no attempt has been made to determine emissivity values for solar radiation during this investigation.

The results of the emissivity determinations show a somewhat greater heat loss by radiation than was formerly believed to exist for the various surfaces commonly met with in practice. For instance, a commercial rough steel pipe in a room at 70 deg. fahr. with the pipe surface at 100 deg. fahr. loses over 60 per cent of the total heat loss from the surface by radiation. The same pipe at a temperature of 1000 deg. fahr. loses about 86 per cent of its heat by radiation.

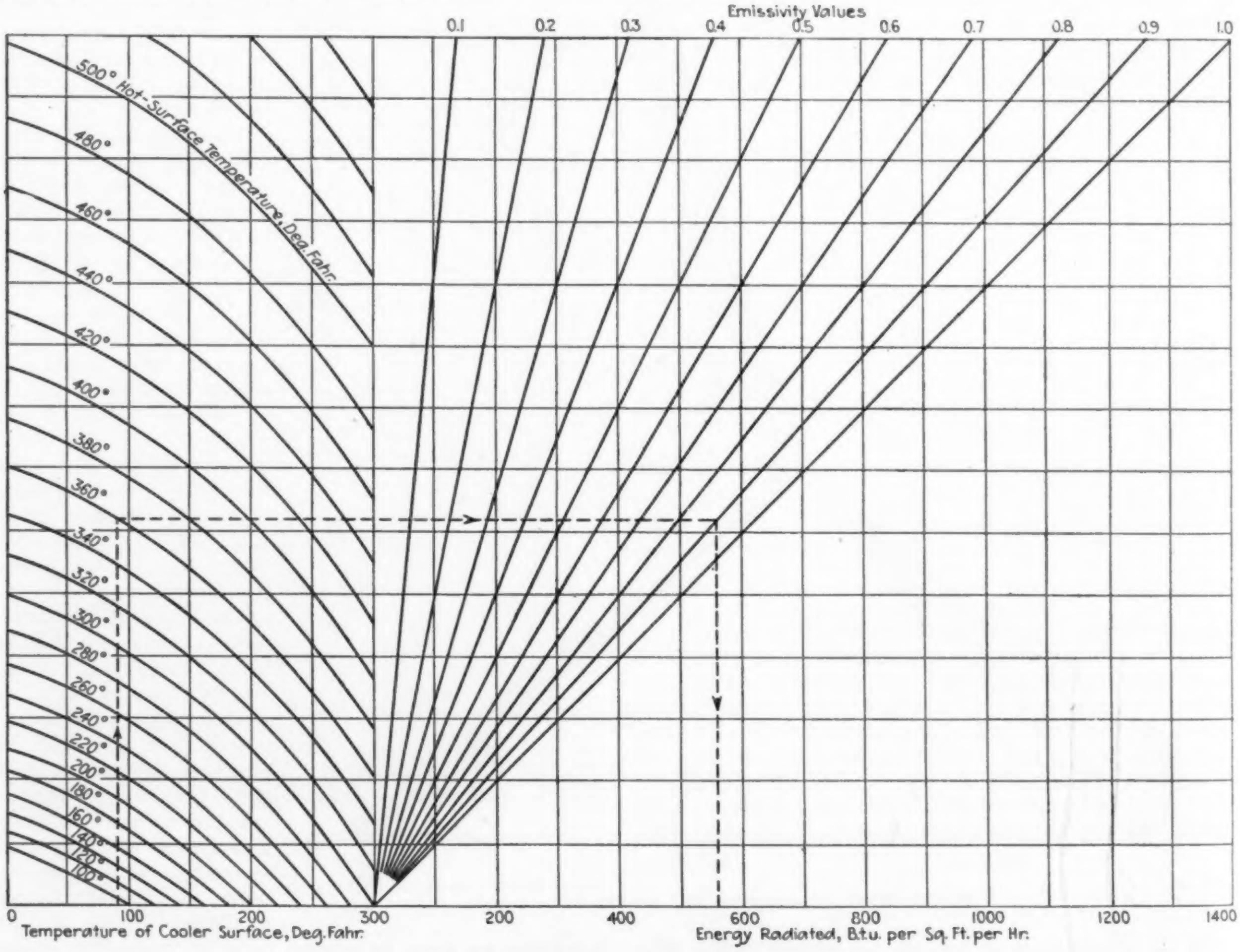

Fig. 4 Heat Transmitted by Radiation

$$H_c = C \times \left(\frac{1}{D}\right)^{0.2} \times \left(\frac{1}{T_{avg.}}\right)^{0.181} \times \Delta t^{1.266} \text{B.t.u. per sq. ft. per hr.}$$

The heat loss by radiation can be calculated by the equation

$$H_r = 17.23 \times 10^{-10} \times e(T_1^4 - T_2^4)$$

Table 1 gives values of e for some of the surfaces met with in practice. It was the author's intention to include a great many more surface values in this paper. However, it is his opinion that practically all the surfaces encountered in engineering practice

To enable the engineer to readily determine the total heat loss from various surfaces the author has prepared several charts which eliminate all calculations for surface temperatures up to 700 deg. fahr. These charts (Figs. 3–5) have been carefully drawn and should give an accuracy of 1 per cent or less in most cases, except for the very low temperature excesses.

The dotted lines show the method of procedure for a 3-in. O.D. horizontal cylinder at a temperature of 360 deg. fahr. with a room temperature of 90 deg. fahr. or a temperature excess of 270 deg. and average temperature of 225 deg. Emissivity value, 0.9.

Referring to Fig. 3, the dotted line shows 298 B.t.u. loss by convection and Fig. 4 shows 560 B.t.u. loss by radiation, or a total loss of 858 B.t.u. by radiation and convection.

The following table gives the values of C to use in Fig. 3 for the various shapes.

Horizontal cylinders	1.016
Long vertical cylinders	1.235
Vertical plates	1.394
Horizontal plates facing upward	1.79
Horizontal plates facing downward	0.89
Spheres	1.82

The actual convection loss per unit area from small horizontal convection loss can be readily obtained from Fig. 3 as follows:

Take, for example, the heat loss by convection from a 2-in.-diameter cylinder 12 in. in height, at a temperature of 360 deg. fahr. with room temperature of 90 deg. fahr. According to Equation [14] in the complete paper, the loss from a horizontal cylinder varies directly as the shape factor or $(1/D)^{0.2}$; therefore, for a short vertical cylinder the loss should vary directly as the shape factor and also directly as the height factor or $(1/D)^{0.2} \times (1/H)^{0.2}$, or for the 2-in.-diameter cylinder 12 in. in height, we have $2 \times 12 = 24$. Using the value of 24 for D or H in Fig. 3 and a value of 2.33 for C, which is the value to use for short vertical cylinders, we proceed from 2.33 for C vertically to 24 for D or H,

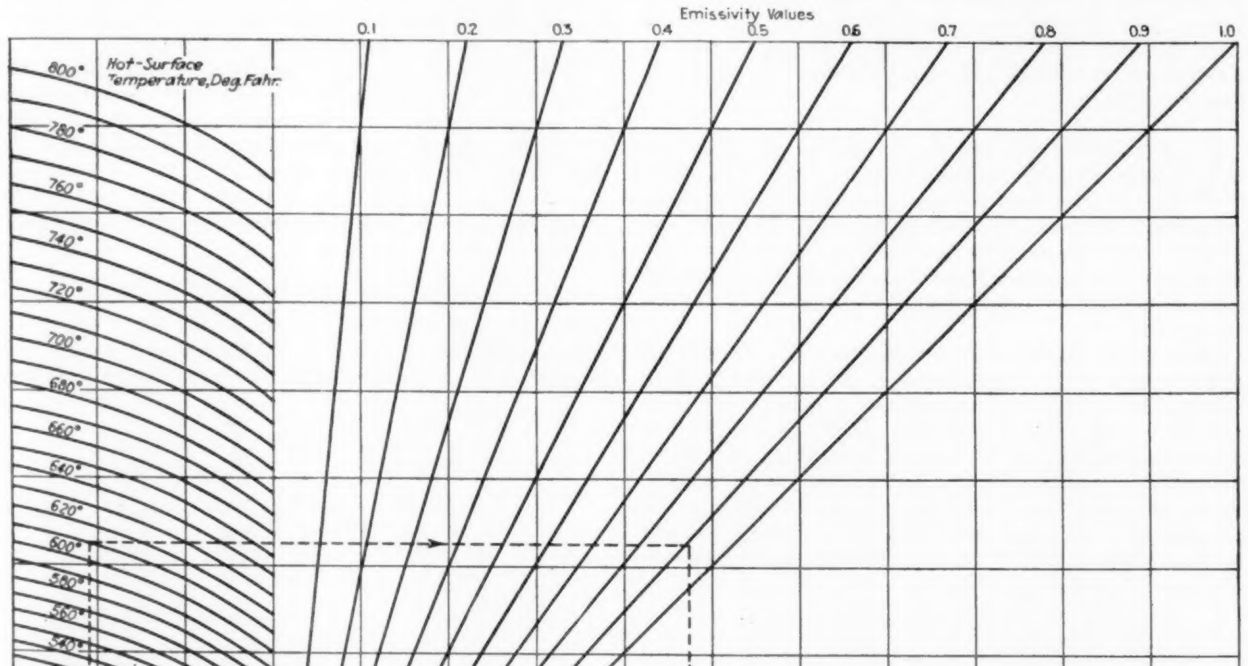

Fig. 5 Heat Transmitted by Radiation

plates and short vertical cylinders decreases as the size of the plate and the height of the cylinder increase. The exact size or height at which the loss becomes constant is not known. Until further experimental work is done it is suggested that 24 in. be taken as the limit.

Convection Loss From Short Vertical Cylinders

In the case of short vertical cylinders, assuming that the effect of height varies as the 0.2 power for lengths up to 24 in. and is independent of height for lengths above 24 in., the approximate thence horizontally to 225 deg. fahr. average temperature, thence vertically to 270 deg. fahr. temperature excess, and thence horizontally to 450 B.t.u. loss by convection from the short vertical cylinder. When the product of $D \times H$ for short vertical cylinders is greater than 24, it will be necessary to assume the probable position of this product above the values of D or H shown in Fig. 3, as the values are given in the diagram up to only 24 in. so as not to conflict with the statement given above that the loss per unit area probably becomes constant for values of D or H above 24 in.

Diamonds as Metal-Cutting Tools

By C. L. Bausch,[1] Rochester, N. Y.

In this paper the author recites the history of the use of diamond tools in the plant of the Bausch & Lomb Optical Co., which he believes to be quite representative of the use of diamonds in general. Diamonds were first used in the turning of materials which were too hard for steel tools. Their next use was in obtaining high finishes on non-ferrous metals, and this was followed by their use on work requiring extreme accuracy. In all cases, high speed was obtainable, although heavy cuts have never been possible with diamond tools. Data are given regarding the proper selection and setting of diamonds in relation to the cleavage plane of the material, as well as on cutting speeds and feeds, life of diamond tools, limitations due to vibration, etc.

As PROBABLY all know, the diamond is a crystalline form of carbon and the hardest substance known. The author was once told that tantalum or some alloy of tantalum was as hard, but he does not believe this to be universally conceded, nor, if it were, would it have much bearing on the subject-matter, as it is quite certain that tantalum has never been used as a cutting tool or been put to the other industrial uses that the diamond has.

Diamonds are usually found in nature as single crystals, but they also occur as a conglomeration of tiny crystals, in which form they are employed to a certain extent in industry. These crystals are called "black diamonds" and "carbonados," and sometimes incorrectly "bort." Bort, however, is the proper name for discolored and faulty single-crystal diamonds not suitable for jewels, and it is this form of diamond with which this paper will deal. These crystals belong to the cubic system, generally assuming the form of an octahedron or a form symmetrically derived therefrom.

Early Industrial Uses of Diamonds

In looking into the history of the diamond and its industrial uses, the first mention the author has been able to find is in regard to its use in powdered form on a lap in 1476 for faceting jewels. For centuries apparently no further use of them was made, but in recent years they have become quite indispensable in industry for cutting and drilling glass, porcelain, and other hard materials and for the making of draw dies for fine, very accurately sized wires. They also find use as very fine graduating tools, and of late have been employed for turning and boring tools. The first use of diamonds for this purpose, the author believes, was by European instrument makers who used them for turning the taper on transit centers.

The practice which will be outlined in the following paragraphs is that developed in the plant of the Bausch & Lomb Optical Co.; and the author's study of recent literature on the subject leads him to believe that this is quite representative of the development in industry at large.

Where Diamond Tools Are Especially Useful

Diamonds are used generally where the material to be machined is too hard for a steel tool or where greater accuracy or better finish is wanted than can be obtained when using steel tools.

To make a good diamond tool for such purposes, a careful selection of bort is necessary, and then a very careful positioning of the diamond in its holder so that a cleavage plane will be parallel to the top surface of the tool. The cleavage planes in good crystals are very pronounced and are parallel to the faces of the crystal. In stones less well defined it is necessary for the diamond grinder to shift the stone around until he finds the grain by the ease with which the grinding is accomplished.

In the past some have made a practice of electroplating the diamond and then soldering it to the holder, but the best practice now seems to be to set and braze it into a steel holder. The end of the holder is bored to fit the diamond and is then slit with a number of saw slots as shown in Fig. 1; the diamond is then inserted in the hole and the tongues formed by the slots are pressed down to hold the stone, after which it is finally brazed into place.

Diamond Tools for Various Purposes

Diamonds can be ground into almost any shape for special forming jobs, but for straight turning and boring a fairly well standardized form has been adopted. Fig. 1 shows this form

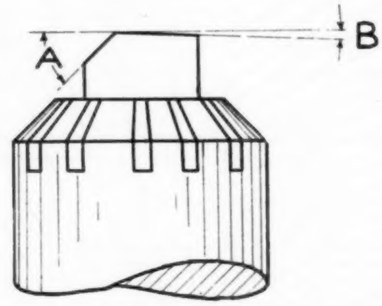

Fig. 1 Standard Form of Diamond Tool for Turning and Boring

which has been found to give very good results. For turning tools, the angle A is made 45 deg. and angle B, 2 deg. The face clearance of A is about 10 deg., and of B, about 2 deg. This clearance angle of B varies somewhat with the type of work that the tool is supposed to do. On very hard material it may be made as great as 5 deg. For boring tools it is made 5 to 8 deg., depending upon the size of hole to be bored. In general, it is kept as small as possible and still have clearance. No lip angle is ever given to the top of the tool.

Facing tools require more clearance than turning tools, but less than boring tools. Good practice is about 3 to 4 deg.

Figs. 2–7 show diamond tools of several types. Fig. 2 shows a top view and Fig. 3 a perspective view of a special-form radius tool. Figs. 4–7 show respectively top and perspective views of a regular turning tool, a combined turning and facing tool, a regular boring tool, and a combination boring and facing tool. It will be noted that a secondary clearance is shown on some of these tools—put on with the idea of clearing the heel of the tool.

The turning tool when used is tilted around so that the angle B becomes smaller where coarse feeds are used or when a specially brilliant surface is wanted on the work. When setting the tool for the latter purpose it must be kept in mind that this sort of finish requires really a burnishing operation after the cut is taken.

[1] Manager, Research and Engineering, Bausch & Lomb Optical Co. Mem. A.S.M.E.

Contributed by the Machine-Shop Practice Division for presentation at the Rochester Meeting, Rochester, N. Y., May 13 to 16, 1929, of The American Society of Mechanical Engineers. All papers are subject to revision.

Note: Statements and opinions advanced in papers are to be understood as individual expressions of their authors, and not those of the Society.

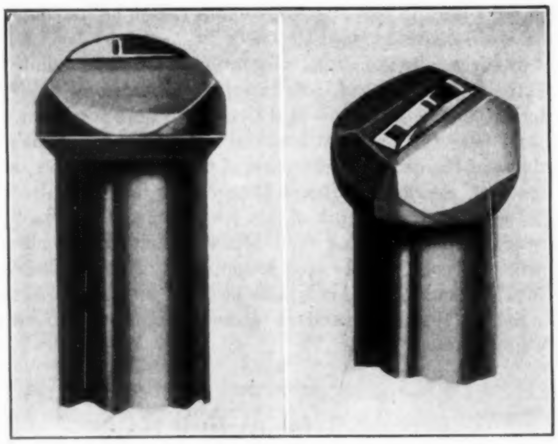

Fig. 2 Top View of Special-Form Radius Tool

Fig. 3 Perspective View of Special-Form Radius Tool Shown in Fig. 2

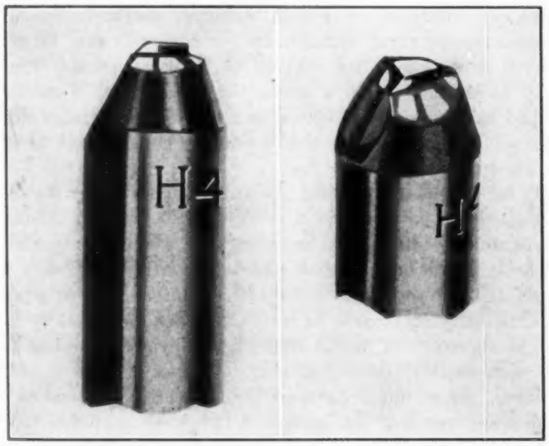

Fig. 4 Top and Perspective Views of Regular Turning Tool

The angle *B* is sometimes practically reduced to zero and the tool set above center so that the clearance face of the angle *B* becomes tangent to the work being turned. To further enhance this burnishing effect for very high polish, the tool is rotated so that the edge of the tool away from the cutting edge is higher than the other edge, as shown in Fig. 8, which is a front view looking at the work through the tool. This angle of tilt *C* may be as high as 45 deg. for turning very soft metals. It is obvious that this practice cannot be followed in boring.

Vibration the Limiting Factor in Diamond Turning

In attempting to tabulate results of his experiments in finding maximum possible surface speeds and feeds, the author was forcibly impressed by the fact that the surface has not yet been scratched, so to speak, in this direction. The main limiting factor seems to be that of vibration. The diamond will stand any temperature as long as it is cutting freely and there is no vibration. Several machine-tool builders have awakened to this fact and are building special machines for diamond boring and turning. Big, generous bearings are needed, or rugged ball-bearing construction. For turning work between centers, the author's company has found dead-center lathes with a spring pressure on the tail center very satisfactory. This is not practical of course on heavy work, but is difficult to better on work up to about 4 in. in diameter and 6 to 8 in. long. Where this practice cannot be followed or where ball-bearing spindles cannot be used, the machine must have well-fitted bearings and should be run in to normal operating temperature before really accurate work can be done. By taking these precautions it has been found possible

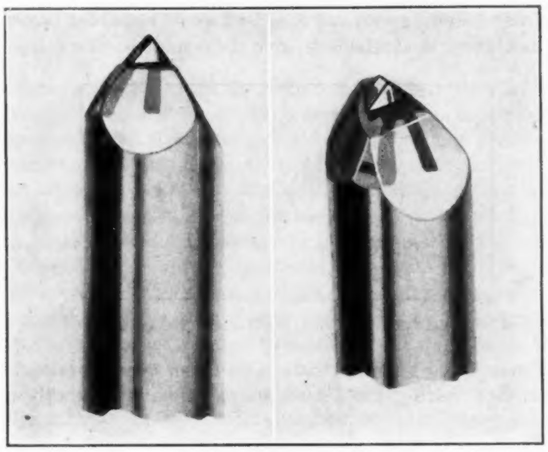

Fig. 5 Top and Perspective Views of Combined Turning and Facing Tool

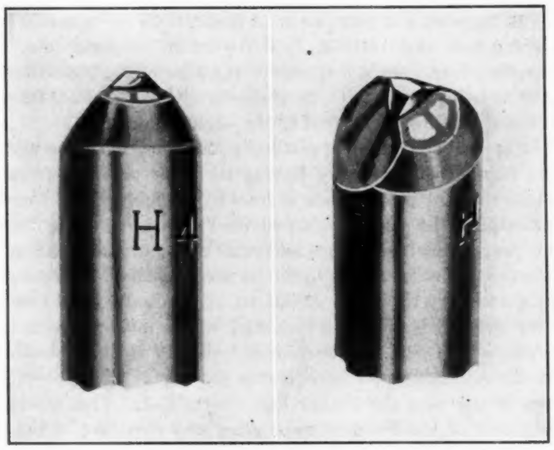

Fig. 6 Top and Perspective Views of Regular Boring Tool

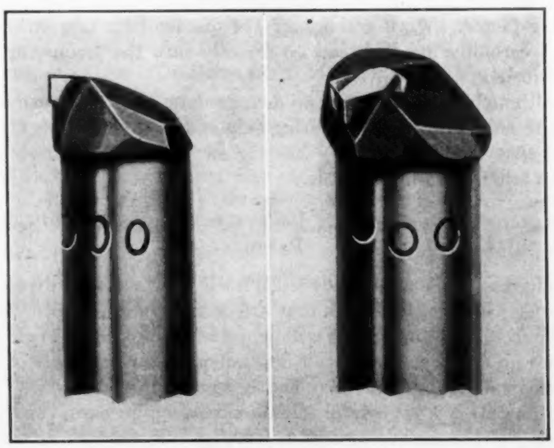

Fig. 7 Top and Perspective Views of Combined Boring and Facing Tool

to finish hard cast-bronze periscope heads 12 in. in diameter and about 30 in. long to within 0.0002 in. over their entire length. This job required two cuts, one on the rough casting and one finishing, running at 210 r.p.m. with a feed of 0.007 in. per revolution. A clearance angle of 5 deg. was used on the tool. The same tool was used on both the roughing and finishing cuts. In this case a higher speed and finer feed would have been better, but no machine was available to give these more ideal conditions.

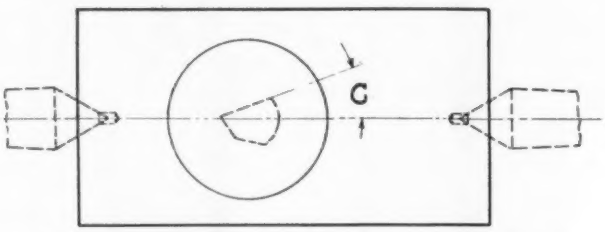

Fig. 8 Tilting of Tool to Obtain Burnishing Effect

If everything is rigid, cuts can be taken over depressions and holes, over which the tool must jump, without appreciably affecting accuracy.

Speeds and Feeds Employed

With the equipment regularly in use, surface speeds of 1000 ft. per min. are possible and feeds from 0.001 in. to 0.003 in. per revolution, with a depth of cut of from 0.015 in. to 0.025 in. on roughing cuts and 0.004 in. to 0.010 in. on finishing cuts. The author has found surface speeds of anywhere from 200 to 1000 ft. per min. being used, with no indication that the 1000-ft. speed shortened the life of the tool in the slightest degree.

The speed of turning is practically independent of the material being turned, the company having turned everything from soft babbitt to hard bronze that a steel tool would hardly touch, at substantially the same speed provided vibrations did not occur. With proper machine design and careful technique in the setting of the tool, wonderful results can be accomplished. Turning and boring accuracy to within 0.0001 in. is obtainable, and beautiful mirror-like finishes can be obtained which must be seen to be appreciated. Costs can be reduced greatly as it is possible to turn thousands of pieces with one setting of the tool—15,000 pieces in one case the author has a record of. This means the elimination of the frequent regrinding and resetting of the tool, a possible easing up on inspection, fewer rejections and securing at the same time more accurate work, a beautifully finished product, and the elimination of polishing costs which in some cases is a big factor. Work coming off the diamond turning lathes, if it is carefully handled, can go directly into the lacquering department.

Although the author has no definite data at hand, he can state that many of those who are using diamond tools on bearing metals feel that more satisfactory bearing surfaces are obtained than with other finishing methods.

Diamond Tools Specially Useful in Machining Thin, Flat Parts

The use of diamond tools lends itself very successfully to the finishing of thin, flat parts that are ordinarily difficult to clamp without distortion. Using a diamond which has no lip angle and hence no lifting component, it is possible to machine parts of this kind by clamping them very lightly against the edges.

Lubrication is not helpful in diamond machining except as a protection of the surface against tarnishing. There may be exceptions to this in working certain materials, but not within the company's experience. The author understands that lubricants have been used in working tough copper, but he has done this satisfactorily without its use.

It was originally the author's intention to tabulate definite data as to the proper angles of tools and the exact setting for different materials, but he finally decided that there were too many variables to make this practicable at this time. These variables are: hardness of the diamond, direction of the cleavage planes, shape of the tool, clearance angles, setting of the tool for height and angle, speed of work, depth of cut, feed, and physical characteristics of the material being machined, which latter, as is generally known, vary considerably even in supposedly similar material.

Notwithstanding this, it is now possible with standard-shape tools to train set-up men and operators in a short time to successfully use diamond tools.

From Model to Full Scale

IT MAY with much truth be said that all past and present progress in the field of engineering, civil, mechanical, and electrical, is based on an advance from the small- to the large-scale experiment. Behind the giant dams of today, the huge liners, locomotives, aeroplanes, airships, steam turbines, and generators, we find small-scale forerunners, the experience derived from which has enabled us to pass upward from the small to the large. In a sense, the engineer's life can be described as a constant endeavor to apply the knowledge derived from models as an aid in the design and construction of works on an enlarged scale.

By far the most important general principle so far discovered or enunciated in connection with the relationship which, for comparable results, should be preserved between the model and full-scale conditions, is that associated with what have come internationally to be called Reynolds numbers. This principle is particularly applicable to tests on bodies immersed in fluids, and is therefore of prime importance in naval, architectural, and aeronautical investigations. A brief study of it will, however, throw much light on the difficulties associated with small-scale research in general. Osborne Reynolds showed that in tests involving the immersion of a body in a fluid, compensation for the effect produced by the small scale of the model could be obtained by increasing the speed of the fluid past the model or by decreasing its kinematic coefficient of viscosity. In other words, in order to obtain from a model results that would be applicable without change to the full-scale construction, the model ought to be tested under conditions such that the factor vl/ν was the same in numerical value as the corresponding factor for the full-scale conditions. If the coefficient of viscosity be assumed constant, this factor implies that as the scale l of the model is decreased, the velocity v of the fluid past the model—or of the model through the fluid—ought to be increased. In aeronautics the size of model that can be tested in a wind tunnel is at the greatest a fifth of the full-scale aeroplane, and a hundredth of the full-scale airship. The speed with which the air can be drawn through the tunnel is also limited. Even with the largest-sized model and the highest wind velocity, the Reynolds' numbers in aeronautical tests are often only one-fifth to one-tenth of what they should be in order to duplicate the corresponding numbers reached in full-scale practice. What allowance is to be made in passing from the model results to the prediction of the full-scale results, when, as in this instance, the data are derived from model tests knowingly carried out under conditions that do not reproduce the full-scale conditions? The answer would appear to be that in the intensively explored field of aeronautical research, we have nothing to guide us.—From an editorial in *The Engineer* (London), March 22, 1929, p. 325.

Lumber Conservation in Woodworking Plants

Outline of Method for the Control of Waste in the Cutting of Lumber Into Fabricated Parts Which Has Been Successfully Installed in Numerous Plants

By CARLE M. BIGELOW,[1] BOSTON, MASS.

SOME ten years ago the author had an unusual opportunity to study the woodworking industry in an association of woodworkers numbering over sixty plants, manufacturing a wide range of product, and on a basis where true comparison between individual plants was readily possible. This study led to further investigation in many isolated plants of different branches of the woodworking industry. While many fundamentals as to manufacturing methods and general management resulted, the problem of waste control in the cutting department was one which proved continuously difficult of solution. About that time, however, a problem in the cutting of knitted fabric into garments presented itself and was satisfactorily solved. There is a very close analogy between knitted fabric and lumber, as both are extremely variable in quality. From the solution of of this cutting problem dealing with knit fabric, came the fundamental on which was based the method outlined in this paper for the control of waste in the cutting of lumber into fabricated parts, which has since been installed in several score of woodworking plants, covering practically the entire field of woodworking products.

It will be the purpose of this paper to cover theory only in so far as necessary for an understanding of the fundamentals of the solution, and to emphasize principally the practical installation of the method.

In considering the utilization of lumber we must first realize that we are dealing with a very variable material. No two trees ever grew exactly alike, and very few boards of lumber cut from them are alike. If a tree grows in a high, windswept area the texture of the lumber will be entirely different from what it would have been had the tree grown in an enclosed, low, swampy area. When lumber reaches the manufacturer it has been graded according to standards which, while they have been carefully determined, are still somewhat variable. The author thinks any practical woodworker will agree with him that the lumber he receives today is considerably different from that shipped for the same grade ten years ago. There is a constant degrading going on, which will doubtless become more marked as the lumber supply becomes more limited. We therefore find our first variable in the material itself.

Next, it is obvious that a greater percentage of lumber can be cut into clear stock if the cuttings are short and small, than if they are long and large. We therefore have a second variable in the product into which the lumber is cut. In the large majority of woodworking plants the assortment of cuttings is constantly changing; therefore the limits of this second variable are often very undefined.

Given, therefore, a variable material and a variable product, it must be seen that the resultant production and waste percentage, even if we consider the effort of the labor involved as constant both in judgment and effort, will be variable. To mitigate this effect it is necessary that the payment be predicated not upon the immediate results only, but upon the long swing of results for a considerable period of time. Wherever there is such a strong quality or judgment requirement as in the utilization of a variable material, the material utilization and rate of production must of necessity be differential; in other words, supposing that a man is cutting up lumber at a definite speed, it is obvious that the resultant production will be indirectly proportional to the waste percentage. That is, supposing he cuts a thousand feet of lumber in a certain time and in one case the waste is 40 per cent and in another case 60 per cent, it is obvious that his rate of resultant production varies in inverse proportion to the waste difference.

In many plants an attempt to standardize rate of production by the elimination of this variable has been approached by paying the workmen on the intake footage, or, in other words, on the amount of rough lumber they cut, irrespective of the resultant net production. In one automobile-body plant this resulted in an annual wastage of $113,000 in lumber, as it is perfectly obvious that the incentive was applied so that the effort of the men was directed toward passing a maximum amount of lumber through the department, regardless of what was produced. Low wastages or proper utilization of material cannot be obtained by paying in terms of intake. Other plants endeavoring to overcome this have attempted to pay on net production only. It is obvious that this is very unfair to the worker, as variations in quality of lumber or size of cuttings so affect the net production that he is not fairly rewarded for his effort. In paying on any basis for production in the cutting of lumber, a wide variation in concomitant effort between individual operations usually results from the following reasons:

If the cuttings are long the task of the cross-cutting operatives is reduced, while that of the rip-sawyers is increased. On the other hand, if the cuttings are short at the cross-cut operation the task is considerably increased. To compensate for this, therefore, it has been found advisable to pay the entire cutting department as a group; that is, the group of workers who convert the lumber into definite-sized pieces (usually cutting, ripping, planing, and sticking) are considered as a unit.

The Method

In consideration of all these variables, therefore, a method was devised as follows:

The fundamental of payment is based upon a differential relation between production and wastage. Inasmuch as it is usually found that the cost of material is equivalent to several times the amount of labor involved in its cutting, a greater incentive is paid for reducing wastage than for increasing production. A certain relation between these two results is therefore made obligatory for the payment of extra compensation.

A definite group of workers is assigned to the operation and their results calculated in two factors—*Waste* and *Clearance* (or Production).

Waste is determined by subtracting *Clearance* (or Production) from *Intake* (or Consumption).

Intake consists of lumber *brought into* the group, corrected by the amount of difference between the inventory (of the stock of lumber, edgings, process material, finished material, etc.) in the

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[1] President, Bigelow, Kent, Willard & Co., Inc., and Waste Eliminators, Inc. Mem. A.S.M.E.

Contributed by the Wood Industries Division for presentation at the Rochester Meeting, Rochester, N. Y., May 13 to 16, 1929, of The American Society of Mechanical Engineers. Greatly abridged.

group floor space at the end of the week or pay period, and that in the same location at the beginning of the same interval.

The weekly computation of waste is therefore, in essence, as follows:

Start with	Inventory Last Week End (A)
Add	Intake to Group (B)
	Gross Intake ($A + B$)
Subtract	Withdrawals (C)
	Corrected Gross Intake ($A + B - C$)
Subtract	Inventory This Week End (D)
	Net Intake ($A + B - C - D$)
Subtract	Clearance This Week (E)
	Waste $= (A + B - C - D - E)$

Percentage of Waste = Waste Divided by Net Intake

$$= \frac{A + B - C - D - E}{A + B - C - D}$$

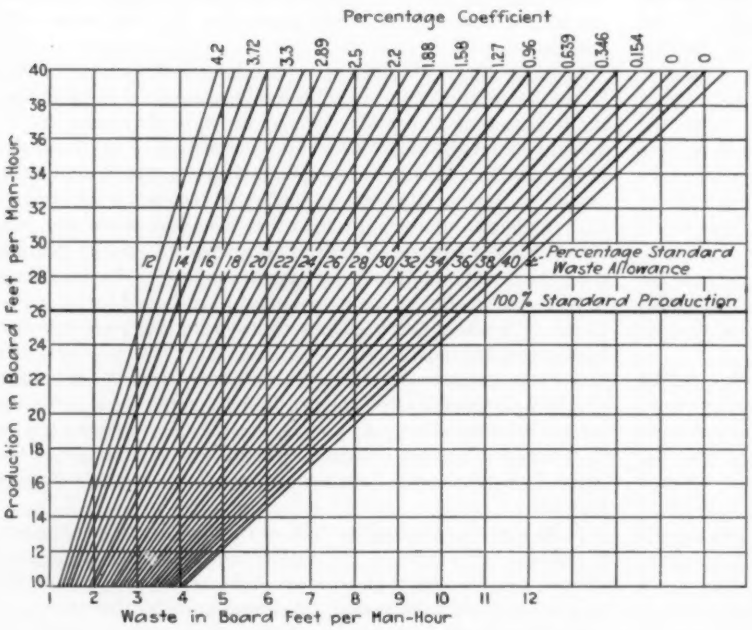

Fig. 1 Production-Waste Ratio Chart
(The percentage coefficient multiplied by the board feet produced per man-hour gives the bonus percentage for the hours worked.)

Clearance (or Production) consists of the equivalent feet b.m. contained in the product, based on standard net-content constants for each part of product. By dividing this footage by the man-hours of labor, a factor of Board Feet per Man-Hour is determined.

These calculations are usually made on a weekly, bi-weekly, or monthly basis. Next, a chart is prepared in the following manner:

The first step is to plot the relations between board-feet-per-hour production and waste, for a range of waste percentages and production somewhat wider than the standard. Such a chart is shown in Fig. 1. The percentage coefficients at the top of the chart are determined as follows:

A graph of bonus percentages for waste eliminations is plotted as shown in Fig. 2. The percentages of bonus used are determined by experience, and are set to produce the necessary incentive. The standard board footage per hour on Fig. 1 is 26. The waste bonus shown in Fig. 2 applies specifically to this production, therefore the percentage bonus allowed for any percentage of waste divided by 26 gives a coefficient which, if multiplied by any board-foot production, gives an excellent differential bonus percentage for both production and waste.

For example: 30 per cent waste on Fig. 2 is allowed 25 per cent bonus; whence $25/26 = 0.96$ = coefficient for 30 per cent waste; the bonus for a production of 30 ft. b.m. per hr. $= 30 \times 0.96 = 28.8$ (29) per cent; for a production of 25 ft. b.m. per hr. $= 25 \times 0.96 = 24$ per cent; etc. Fig. 3 is then calculated from the coefficients determined on Fig. 1, and gives the direct bonus percentage for each combination of waste and production within the standard range.

Each pay period the Board Feet per Man-Hour and Percentage of Waste are determined and the resultant bonus increment read from the chart. This is paid as a percentage of additional pay to each man in the group. However, to compensate for the very variable conditions involved, instead of paying this on the direct results of the immediate period, a figure is determined for the mean between the current period and several past periods; for

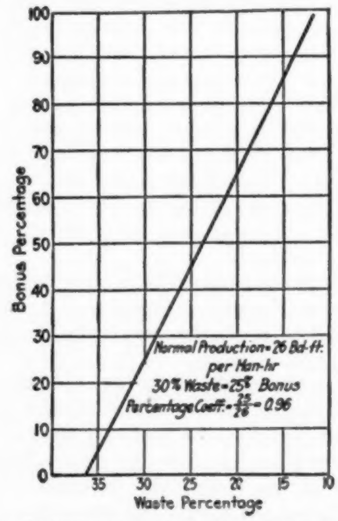

Fig. 2 Graph of Bonus Incentive Plotted Against Waste Reduction at Point of Normal Production

instance, if a weekly basis is used the average percentage of waste for the prior five weeks and the mean between this figure and the waste for the current week is taken as the waste basis of pay. In the same manner the mean between the average Board Feet per Man-Hour for the prior five weeks and the current week is taken for the production basis. The bonus percentage equivalent to these two is then paid the workers.

This group of workers consists of not only the productive workmen, but the foreman, knife grinder and setter, sweeper, and truckers, if any are used. In other words, every one included in the standard group is paid this percentage.

It is very often possible, and is usually the practice in more recent installations, to make a variable allowance for both production and wastage standards. For instance, the above is predicted upon a constant supply of similar-graded or assorted grades of lumber for a fairly constant product. Where great variation in product occurs, it is necessary to set up the production standard in terms of percentage of production effectiveness. When this is done, a definite time allowance for the department is determined for each item of product, and the total allowed times are determined for the clearance of product for the pay period, or, time allowed $= T_A$. The hours actually spent by the group

during the period are, of course, time taken = T_T. Then T_A/T_T = percentage of effectiveness.

To cover the factor of variable lumber supply standard percentages of clearance are determined by applying carefully determined percentages to the lumber intake. In one case these percentages were as follows:

	Per cent
Firsts and seconds	81.5
Selects	75.0
No. 1 Common	70.0
No. 2 Common	55.0
No. 3 Common	35.0

These are used as follows: Suppose a truck of 3500 ft. b.m. of firsts and seconds is brought into the plant. The standard clearance should be 81.5 per cent of 3500 or 2852.5 ft. b.m. If but 2700 ft. b.m. are produced, the percentage of standard clearance = 2700/2852.5 = 94 + per cent.

When these two pay factors—percentage of effectiveness and percentage of clearance—are used, a table such as that shown in Fig. 4 gives the resultant bonus percentage.

Application

A fundamental which must be realized in the use of this method is that the standards cannot be determined upon a purely mathematical basis, but are to a very large extent a matter of judgment, and the author considers that it is practically impossible for this

Waste Percentage \ Production in Board-Feet per Man-Hour	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
36	0	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	4	5
35	0	3	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	6	7	7
34	0	4	4	5	5	5	6	6	6	7	7	7	8	8	8	9	9	9	10	10	10
33	0	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15
32	0	7	8	9	9	10	10	11	12	12	13	14	14	15	16	16	17	18	18	19	20
31	0	9	10	11	11	12	13	14	15	15	16	17	18	19	19	20	21	22	23	24	24
30	0	11	12	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
29	0	12	13	15	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	32	34
28	0	14	15	17	18	19	20	22	23	24	25	27	28	29	31	32	33	34	36	37	38
27	0	16	17	18	20	21	23	24	26	27	28	30	31	33	34	35	37	38	40	41	43
26	0	17	19	21	22	24	25	27	28	30	32	33	35	36	38	40	41	43	44	46	47
25	0	19	21	22	24	26	28	29	31	33	35	36	38	40	42	43	45	47	48	50	52
24	0	21	23	24	26	28	30	32	34	36	38	40	41	43	45	47	49	51	53	55	56
23	0	22	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61
22	0	24	26	29	31	33	35	37	40	42	44	46	48	51	53	55	57	59	62	64	66
21	0	26	28	31	33	35	38	40	42	45	47	49	52	54	56	59	61	63	66	68	71
20	0	28	30	33	35	38	40	43	45	48	50	53	55	58	60	63	65	68	70	73	75
19	0	30	32	35	38	40	43	46	48	51	54	57	59	62	65	67	70	73	75	78	81
18	0	31	35	38	40	43	46	49	52	55	58	61	64	67	69	72	75	78	81	84	86
17	0	34	38	41	44	47	50	53	56	59	62	65	69	71	75	78	81	84	87	91	94
16	0	36	40	43	46	50	53	56	59	63	66	69	73	76	79	83	86	89	93	96	99
15	0	39	43	46	50	53	57	60	64	67	71	74	78	82	85	89	92	96	99	106	109

Standard Waste

Production Standard

FIG. 3 BONUS PERCENTAGES FOR STANDARD RANGE OF WASTE AND PRODUCTION

method to be worked out except by an engineer who not only has had a very wide experience in time study and operation standardization, but is one who knows lumber from its production in the woods to the many problems encountered in its utilization in the plant.

This method has been installed so many times that a standard series of steps has been determined as follows:

1 List all parts in the product
2 Figure standard net-content constants for these parts and finally consolidate them in terms of assemblies if clearance is figured in assemblies
3 Make operational analyses of current and standard waste percentages and of speeds, feeds, and time studies of each individual operation involved
4 Set up a standard group of men, subdividing into groups if there are separate groups of product with separate clearances
5 Initiate current weekly determinations of Percentage of Wastage and Board Feet per Man-Hour Production
6 Start combined waste and production tests
7 Determine past average Percentage of Waste and Board Feet per Man-Hour Production, and total production for at least one year if possible
8 Decide on bonus limits and construct bonus chart
9 Prepare report presenting plan and calculation of resultant savings, including forms and outline of clerical detail for calculations.
10 Maintain graphic chart of results.

Percent of Standard Clearance Obtained \ Percent Productive Effectiveness	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
100	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
99	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
98	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58
97	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57
96	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
95	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
94	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
93	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
92	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
91	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
90	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
89	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
88	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
87	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
86	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
85	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
84	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
83	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
82	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
81	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
80	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

FIG. 4 RESULTANT BONUS PERCENTAGES FOR VARIOUS PERCENTAGES OF CLEARANCE AND OF EFFECTIVENESS

In the complete paper these ten steps are briefly described, examples and data being given and the necessary forms illustrated.

Results

The results of this combined production-yield group bonus in several major industries are tabulated below. All of these results are derived from actual installations and extend over periods from six months to six years.

Product	Original waste, per cent	Standard waste, per cent	Achieved waste, per cent
Library and office equipment	47	20	23
Battery boxes	49	30	35
Kitchen cabinets	23	$19^1/_2$	20
Children's blocks, etc	36	20	25
Saw handles	83	68	73
Commercial fixtures	41	32	34
Oak flooring	40	24	30
Auto bodies	44	37	35

	—Board feet (net) per man-hour—		
	Original production	Standard production	Achieved production
Library and office equipment	13	26	20
Battery boxes	21	45	40
Kitchen cabinets	51	60	57
Children's blocks, etc	20	51	27
Saw handles	5	$12^1/_2$	10
Commercial fixtures	22	110	100
Oak flooring	25	52	32
Auto bodies	33	66	65

Control of Boiler-Water Treatment to Prevent Embrittlement[1]

By FREDERICK G. STRAUB,[2] URBANA, ILL.

There is much interest in the question of methods of water treatment to prevent the cracking of boilers, commonly described as embrittlement. The author discusses the necessity for boiler-room control of the treatments used to prevent embrittlement. This control is based upon rapid and sufficiently accurate analyses which may be run readily by the boiler attendants. The analyses discussed are for total alkalinity, sodium sulphate, and sodium phosphate. Details of a colorimetric method for phosphate are given. The article recommends that all boiler-water analyses be checked from time to time by laboratories familiar with water analyses.

THE presence of highly alkaline boiler water in steam boilers serves as an indication that the water might be embrittling in type, and if suitable preventive steps are not taken, the boilers may become embrittled. The first step to be taken is to have the boiler water analyzed to see whether it conforms to the sulphate alkalinity ratio as recommended in section VII, paragraph CA-5, of the Suggested Rules for the Care of Power Boilers, A.S.M.E. Boiler Construction Code. In the event it does not, a thorough inspection should be made of the boiler to make certain that embrittlement has not proceeded to the point where operation of the boiler becomes dangerous. At the same time, steps should be taken immediately to treat the feedwater in some manner so that the water is no longer embrittling. The methods of treatment to be used depend upon the conditions of operation and have been discussed in detail in previous publications.[3] The ultimate aim of the treatment is to maintain within the boiler a predetermined amount of the inhibiting chemical. The two chemicals which are receiving most attention in this respect are sodium sulphate and sodium phosphate. Either one of these salts must be maintained in the boiler water in definite amounts. The sulphate is kept in direct proportion to the total alkalinity in the boiler water, while the phosphate is usually kept at a definite set figure which is largely independent of total alkalinity for normal concentrations.

In order to be assured that the treatment is being properly administered, control of the water treatment must be maintained in the boiler room. This immediately suggests that some one in the boiler room or in close touch with it must run rapid chemical analyses of the boiler water at regular intervals in order to control the treatment. Consequently, rapid and fairly accurate methods of analyses must be instituted which may be put in the hands of men not thoroughly versed in chemistry. Of course, it is well to have more accurate check analyses made from time to time by chemists familiar with boiler-water analyses to check the plant analyses.

The most desirable analyses to be run on the boiler-water sample will be the alkalinity and sodium sulphate or phosphate, depending on the treatment used.

The alkalinity of the boiler water may be determined by titrating a 100-cc. sample of the boiler water with N/5.3 sulphuric acid. The titration value in cc. times 100 gives the total alkalinity (in parts per million) as sodium carbonate. In event the total alkalinity is low, acid of lower normality may be used. The indicator to be used may be methyl orange if the water is clear and low in organic matter. The best indicator for any particular water may be determined easily by the laboratory which is checking the analyses.

The standard method for determining sulphate has been to acidify the sample of boiler water with hydrochloric acid, boil, and add barium chloride solution. The sulphate is precipitated as barium sulphate, which is filtered, washed, ignited, and weighed as $BaSO_4$. The sodium sulphate is calculated from the weight of the precipitate. This method is not suitable for boiler-water control since it involves familiarity with chemical procedure such as filtration, washing, and accurate weighing.

When barium chloride is added to a slightly acid solution containing sulphate, the barium sulphate first forms as a very finely divided precipitate which does not settle rapidly. As early as 1904 methods have been in use for determining the sulphate content of a solution by measuring the turbidity produced. S. W. Parr[4] makes use of this principle and calls it the photometric method. He measures the limiting depth of solution through which a standard light may be seen. The instrument is standardized against solutions of known sulphate content. A similar method is used whereby the turbid solution is in a container of such a thickness that the standard light will not penetrate. The solution is diluted with distilled water until the light becomes visible. The volume of the diluted solution is a measure of the sulphate content. This method is commonly described as the turbidity method for sulphate.

The objection to these methods is that the fineness of the precipitate depends upon the acidity, amount of barium chloride used, other salts in solution, temperature, and rate at which the barium chloride is added. It is hard to control all the factors at once, and often two operators working on the same water will obtain results of wide variation. If this method is tried in a particular plant and the operators can so regulate its operation that concordant checks may be obtained with analyses made by the gravimetric method, it may be used with assurance that the results are reliable. But its use without this preliminary checking, followed by intermittent checking from time to time, is not advisable.

A different method of determining the sulphate content using an indirect method is in use in some plants. This method involves the determination of the specific gravity by means of an extremely sensitive hydrometer. The sodium hydroxide, sodium carbonate, and sodium chloride contents of the boiler water are determined by titration. The specific gravity is a

[1] This article is an elaboration of part of the material that has appeared in Bulletins 155 and 177 of the Engineering Experiment Station of the University of Illinois. The publication of this article has been authorized by Dean M. S. Ketchum of the Engineering Experiment Station. The funds for this investigation were contributed by the Utilities Research Commission of Chicago, Ill.

[2] Engineering Experiment Station, University of Illinois.

[3] "Water Treatment to Prevent Embrittlement," F. G. Straub; paper read before American Water Works Association, June 12, 1928. "Embrittlement Prevention in Steam Boiler," *Power Plant Engineering*, Feb. 1, 1929.

Contributed by the Joint Research Committee on Boiler-Feedwater Studies for presentation at the Rochester Meeting, Rochester, N. Y., May 13 to 16, 1929, of The American Society of Mechanical Engineers. All papers are subject to revision.

[4] *Jl. Am. Chem. Soc.*, vol. 26 (1904), p. 1139.

measure of total solids. The total solids, minus the sodium hydroxide, carbonate, and chloride, gives the sodium sulphate. On certain pure waters this method gives consistent checks with the gravimetric method. If organic matter is present, the determination of hydrate and carbonate alkalinity becomes difficult. This would lead to much error in the sulphate. The reading of the hydrometer is somewhat difficult, but an experienced operator has little trouble in this direction. This method likewise should be checked against the gravimetric method at the beginning and at frequent intervals to assure correct results.

The standard analysis for phosphate involves the precipitation of the phosphate as phosphomolybdate in a nitric acid solution of definite acidity with an excess of ammonium nitrate present at a temperature just below the boiling point. The precipitate is filtered and washed with neutral ammonium nitrate solution. The washed precipitate is ignited and weighed, or it is dissolved in standard sodium hydroxide solution and the alkaline solution titrated with standard nitric acid. This method is not suitable for boiler-room control. It has been modified to the point where the precipitate, instead of being filtered, is allowed to settle in a bulb having a calibrated capillary tube sealed in at the bottom. The volume of precipitate which settles in this tube is a measure of the phosphate content. This method is suitable for boiler-room control. It should also be checked against the standard method in order to insure its proper operation. Due to the fact that the precipitation must be made in the hot solution, it involves equipment for heating the solution. When a large number of boiler waters are to be tested, this heating becomes inconvenient.

The author has modified a colorimetric method which has been used for phosphate determination in blood, urine, and soil, so that it may be used in the rapid determination of phosphate in boiler waters.

The determination of the phosphate is dependent on the fact that molybdenum present as phosphomolybdic acid may be reduced in the presence of an excess of molybdic acid. The reducing agent used is hydroquinone. If hydroquinone is added to an acid solution of molybdic acid, no phosphate being present, the solution will be colorless when treated with alkaline sulphite, but if phosphate is present, phosphomolybdic acid is formed and reduced, giving a blue color. As small an amount as 5 p.p.m. of phosphate gives a distinct blue color in this test.

SOLUTIONS

Molybdic Acid Solution. Dissolve without heat 125 grams of pure ammonium molybdate in about 2 liters of phosphate-free distilled water; 75 cc. of concentrated H_2SO_4 are slowly added and the volume made up to $2^1/_2$ liters (roughly). A slight blue coloration does not hinder the use of this solution.

Hydroquinone Solution. Dissolve 50 grams of pure hydroquinone in about $2^1/_2$ liters of phosphate-free distilled water and add 3 cc. of concentrated H_2SO_4.

Carbonate-Sulphite Solution. To 6 liters of distilled water add 1500 grams of commercial soda ash; dissolve 225 grams of sodium sulphite in 1500 cc. of water and add.

Stock Solution of Phosphate. Pure monopotassium phosphate is finely ground, dried at 105 deg. cent. for three hours, cooled, and kept in desiccator. Of this salt 0.1432 gram is dissolved in distilled water, 5 cc. of concentrated H_2SO_4 added, and made up to 1 liter in a volumetric flask with distilled water; 1 cc. of this solution contains one-tenth of a milligram of PO_4.

Sulphuric Acid Solution. Add 300 cc. of concentrated H_2SO_4 to about 2200 cc. of distilled water; this is labeled H_2SO_4.

DETERMINATION OF PHOSPHATE

Measure 50 cc. of the filtered sample of boiler water into a 250-cc. volumetric flask, and add 10 cc. of sulphuric acid. To the flask 5 cc. of molybdic acid are added, followed by 5 cc. of hydroquinone solution. After five minutes, 15 cc. of the carbonate-sulphite solution are added, mixed, and the flask made up to volume.

Measure 10 cc. of standard phosphate solution by a pipette into a 250-cc. volumetric flask and 20 cc. into a second flask; 40 cc. of distilled water are added to the first and 30 to the second, followed by the procedure in the determination of phosphate.

Place the flask containing the sample of boiler water between the two flasks containing the standard solutions and compare colors. If the color is lighter than the flask containing the 10 cc. it contains less than 20 p.p.m. of PO_4. If it is between the one containing the 10 cc. and the one containing 20 cc., it has between 20 and 40 p.p.m. If it is darker than the one containing 20 cc., it contains over 40 p.p.m.

Different maximum and minimum values may be established by changing the amount of standard phosphate solution used.

The presence of certain organic matter which gives marked color or high iron content will interfere with this phosphate determination. The color is not permanent; consequently, comparisons must be made within 15 minutes after the addition of the sodium carbonate solution. These phosphate results should of course be checked against the gravimetric results to make certain the results obtained are correct.

In reporting the results of boiler-water analyses, it would be well to keep all results in p.p.m. The total alkalinity should be reported in terms of sodium carbonate, the sulphate as sodium sulphate, and the phosphate as PO_4.

Looking Forward in Steel

HOW much steel per capita will Americans consume in 2000 A.D.? Can the future be forecast from the past? How far will the law of diminishing returns act in restricting the increase per capita of steel use?

Population experts vary in their forecasts of population at the turn of the next century. From the present 120,000,000 Americans some prophets see 240,000,000 in 2000 A.D., while others figure the best population at that time will be 185,000,000.

Fifty years ago, in 1878, with the population 47,000,000 the per capita consumption of steel was 34 pounds. In 1926 the population was 120,000,000 and the per capita steel consumption 959 pounds. But in 1916 it was 950 pounds and in intervening years it has varied above and below the latter. Apparently the steady increase has been checked.

Steel-ingot production in 1928 was about 50,000,000 tons, and steel castings added more than another million tons. Population of 185,000,000 would be about 50 per cent gain, and on the same basis as in 1928 would call for an annual output of 75,000,000 tons of steel, which does not seem too great to expect in view of the growth of tonnage in the past 50 years. Should the other estimate, 240,000,000 persons, prove true, steel requirements, on the 1928 basis, would be close to 100,000,000 tons, still not an impossibility.

But perhaps increased use of alloys to make steel stronger, pound for pound, lessening tonnage for the same work, may cut into this total materially. Perhaps use of other alloys, those of aluminum or some of the now rare metals, may reduce requirements of steel per capita below the proposed rate of growth.

What has happened in the past 50 years makes the prophet for 70 years hence believe his most roseate dreams for tonnage may be far outdone by the reality.—*Iron Trade Review*, March 14, 1929, p. 724.

Research in Heat Transmission in the United States

A Condensed Summary of the Activities of the Committee on Heat Transmission of the National Research Council

By W. V. A. Kemp,[1] New York, N. Y.

EARLY in 1926 the Division of Engineering and Industrial Research of the National Research Council felt that industry required more accurate and readily available information on the science of heat transmission. It was realized that many problems constantly arising in the industrial and domestic life of the nation were concerned either directly or indirectly with this important subject, among which might be mentioned the heating and ventilation of home and factory, many chemical processes, refrigeration, steam engineering, metallurgy, electrical engineering, and civil engineering—in fact, it is difficult to name any engineering or manufacturing activity in which heat transmission does not play either a major or a minor part.

While much information dealing with the flow of heat has been published, and numerous investigators are working on this subject in industrial, educational, and government laboratories, the results of their work are in most cases in the form of isolated test data, difficult of access, and of limited value to industry. This is largely due to the fact that such information has dealt almost exclusively with tests on engineering materials or commercial equipment involving so-called "overall coefficients," and hence only meager information is available on the fundamental laws of heat transfer on which the design and operation of such equipment must necessarily be based.

It was therefore evident that the first activity of the Committee should be an effort to determine the status of our present knowledge in the various fields in which heat transmission is of importance.

To that end the Committee caused to be prepared, and published in the scientific press, several articles by eminent authorities dealing with the different phases of the subject. Independent papers of this character were published under the auspices of the Committee dealing with thermal insulation for a variety of purposes and in several temperature ranges, as well as with the methods of testing insulating materials and the determination of the rate of heat flow. Additional papers were also published covering the promotion of heat transmission through metallic surfaces. A partial list of both classifications is given in Table 1.

From a careful review of the surveys thus collected it was obvious that a more intensive and continued effort would be necessary to attain the objectives which the Committee desired to reach. Therefore, in the fall of 1927 it was decided to employ the full-time services of a paid director whose function should include both the active prosecution of the work of the various sub-committees, and also the solicitation of the necessary funds to finance the Committee's work for a three-year period.

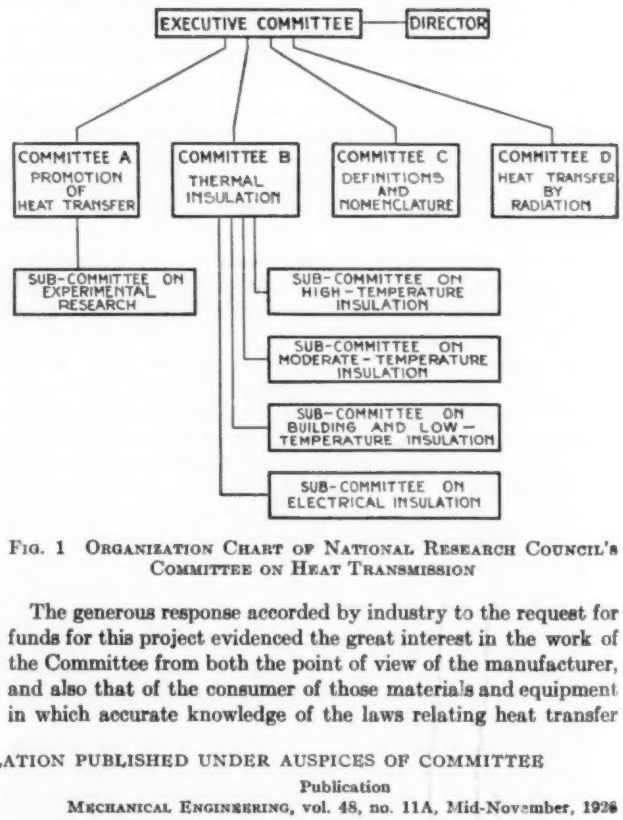

Fig. 1 Organization Chart of National Research Council's Committee on Heat Transmission

The generous response accorded by industry to the request for funds for this project evidenced the great interest in the work of the Committee from both the point of view of the manufacturer, and also that of the consumer of those materials and equipment in which accurate knowledge of the laws relating heat transfer to other physical properties, and hence design, is of paramount importance.

TABLE 1 PAPERS ON HEAT TRANSMISSION AND INSULATION PUBLISHED UNDER AUSPICES OF COMMITTEE

Title	Author	Publication
Status of Heat-Transmission Data and Knowledge in the Refractory Field	P. Nicholls	Mechanical Engineering, vol. 48, no. 11A, Mid-November, 1926
Determination of the Thermal Conductivities of Insulation for Temperatures up to 1000 Deg. Fahr. on Other Than Flat Surfaces	R. H. Heilman	*Refrigerating Engineering*, vol. 13, p. 129, Oct., 1926 Mechanical Engineering, vol. 48, no. 11A, Mid-November, 1926
Heat Transmission from Condensing Steam to Water in Surface Condensers and Feedwater Heaters	W. H. McAdams, T. K. Sherwood, R. L. Turner	Trans. A.S.M.E., 1926
Heat Transfer for Forced Flow of Air at Right Angles to Cylinders	E. L. Chappell, W. H. McAdams	Trans. A.S.M.E., 1926
Methods That Have Been and Are Being Used for Measuring Heat Transmission	F. G. Hechler	*Refrigerating Engineering*, vol. 13, p. 121, Oct., 1926
The Guarded-Plate-Heater Method of Testing Low-Temperature Insulators Compared With Several Box Methods	E. F. Grundhofer	Mechanical Engineering, vol. 48, no. 11A, Mid-November, 1926
The State of Existing Data on Heat Transfer Through Insulation in the Moderate- and High-Temperature Fields	L. B. McMillan	Trans. A.S.M.E., vol. 48 (1926)
Status of Heat-Transmission Data on Building and Insulating Materials Employed Under Low Temperatures	P. Nicholls	*Refrigerating Engineering*, vol. 13, p. 276, March, 1927

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In order to most effectively subdivide the work of the Committee, the scheme of organization shown in Fig. 1 was adopted.

The Executive Committee is composed of the Chairman of the general Sub-Committees shown as A, B, and C acting with eight representatives of some of the largest manufacturing interests in the United States and one representative of the National Research Council.

The activities of the Committee on Heat Transmission during the past year may be summed up as follows:

a The critical surveys which were published as shown in Table 1, made it very evident that the underlying definitions and nomenclature were in a highly chaotic condition. Expressions such as "radiation" through a furnace wall, the "conductivity" of a roof construction, obvious misnomers, were and are in current use.

TABLE 2 CONDENSED SUMMARY OF RESEARCH IN HEAT TRANSMISSION IN EDUCATIONAL INSTITUTIONS IN THE UNITED STATES

Educational Institution	Technical Investigation
1 Agricultural and Mechanical College of Texas, College Station, Tex.	Heat Transmission Through Roof Constructions
2 Armour Institute of Technology, Chicago, Ill. Department of Mechanical Engineering	Studies of Heat Transmission of Building Materials
3 Brown University, Providence, R. I. Division of Engineering	Heat Transmission Through Blanket Materials
4 California Institute of Technology Department of Chemical Engineering	Thermal Conductivity of Liquid Films
5 Columbia University, New York City Department of Physics	Testing of Insulating Materials and Woven Goods
6 Georgia School of Technology, Atlanta, Ga. Department of Experimental Engineering	Double-Pipe Cooler and Condenser Testing
7 Johns Hopkins University, Baltimore, Md. Department of Chemistry	Determination of Specific Heats at Low Temperatures
8 Lehigh University, Bethlehem, Pa. Department of Chemistry	Development of Adiabatic Calorimeter
Department of Physics	Conduction of Heat in Metals and Oxides
9 Massachusetts Institute of Technology, Cambridge, Mass. Department of Aeronautical Engineering	Cooling-Fin Research for Airplane Engines
Department of Electrical Engineering	Heat Transmission Through Lead-Sheathed Cables:
Department of Physics	(*a*) Conductivity of Refractories at High Temperatures (*b*) Conductivity of Metals at High Temperatures (*c*) Conductivity of Liquids
School of Fuel and Gas Engineering	(*a*) Development of a Special Form of Optical Pyrometer for Determination of True Temperature of a Luminous Flame (*b*) Investigation of the Laws of Radiation Between Finite Surfaces (*c*) Development of Methods of Calculation for the Design of Industrial Furnaces
Department of Chemical Engineering	(*a*) Dehumidification of a Mixture of a Non-Condensable Gas and Condensable Vapor (*b*) Effect of Heat Transmission upon Friction Drop to the Flow of Liquids in Pipes (*c*) Studies of Coefficient of Heat Transmission While Cooling and Heating Liquids in Both Turbulent and Viscous Flow (*d*) Correlation of Data for Heat Transmission for Water Flowing in Annular Spaces (*e*) Correlation of Data for Heat Transmission for Gases Flowing Both in Circular Pipes and in Annular Spaces
10 New York University, New York City College of Engineering	Conductivity of Insulating Materials Used in Refrigerator Cabinet Construction
11 Pennsylvania State College, State College, Pa. Engineering Experiment Station	Heat-Transmission Studies of Insulating Materials
12 Purdue University, Lafayette, Indiana Department of Physics	Studies of Loosely Packed Insulating Materials
13 Rensselaer Polytechnic Institute, Troy, New York Russell Sage Laboratory	Thermal Conductivity of Metals and Alloys
14 University of Florida, Gainesville, Fla. Department of Mechanical Engineering	Testing of Commercial Iced Refrigerators
15 University of Idaho, Moscow, Ida. College of Engineering	Heat Flow from Underground Cables
16 University of Illinois, Urbana, Ill. Department of Physics	(*a*) Conductivity of Metals (*b*) Surface Tension and Density of Molten Metals
Department of Mechanical Engineering	(*a*) Heat Transmission of Building Materials (*b*) Testing of Heating Systems
17 University of Kentucky, Lexington, Ky. Department of Mechanical Engineering	Studies of Fin-Type Radiators
18 University of Minnesota, Minneapolis, Minn. Department of Engineering Research	Studies of Building Insulation, Including Air Spaces
19 University of Michigan, Ann Arbor, Mich. Department of Chemical Engineering	Studies on the Evaporation of Liquids
20 University of South Carolina, Columbia, S. C. Department of Geology	Studies on the Freezing of Soils
21 University of Tennessee, Knoxville, Tenn. College of Engineering	Heat Losses in Underground Piping Systems
22 University of Washington, Seattle, Wash. Engineering Experiment Station	Heat Insulation of Electrically Heated Hot-Water Tanks
23 University of Wisconsin, Madison, Wis. Department of Physics	Thermal Diffusivity and Conductivity of Soil Materials
24 Yale University, New Haven, Conn. Department of Mechanical Engineering	(*a*) Studies of Automobile Radiators (*b*) Studies of Radiation in Boiler Furnaces

Sub-Committees A, B, and C are technical in character and therefore are composed of engineers and scientists from industry, educational institutions, and the United States Government. The total active membership of these sub-committees is at present seventy-five, although this number will be increased in the very near future by the addition of Sub-Committee D, which will be concerned entirely with heat transfer by radiation.

To end this confusion and clarify our conceptions of the mechanism of heat flow, a sub-committee was appointed to prepare a report dealing with these fundamentals. This report[2] has been completed and, having received the approval of the Executive

[2] Report on Definitions, Nomenclature, Symbols, and Units for Heat Transmission. Copies may be obtained from the office of the Committee, 40 West 40th Street, New York City, at 25 cents each.

Committee, has been published. It comprises a clear, concise statement of the definitions and laws of heat transfer, and it is hoped that the terminology and symbols recommended therein may become as usual in engineering practice as are the volt, ampere, and ohm in the field of electrical engineering.

b One of the most important functions of the Committee has been the dissemination of information relative to technical investigations which have been conducted in the past, or are now in progress, on heat transfer. In order to answer the numerous inquiries received by the Committee relative to special problems of either an industrial or scientific character, a card index has been prepared of all papers published in the scientific or engineering press dealing *per se* with heat transmission. Many industrial, manufacturing, and civic interests as well as educational institutions have availed themselves of this service. In this same connection it was considered advantageous to collect and distribute, in the form of a directory, a survey of research work now in progress throughout educational institutions in the United States. A condensed summary of the work now in hand will be found in Table 2. In order to keep this directory up to date it will be revised at intervals of approximately six months, showing investigations completed and new projects undertaken.

c At the request of several engineering societies, the Committee has undertaken the preparation and publication of four test codes for thermal insulations such as are used in various industrial or engineering applications, and in the necessary ranges of temperature. A statement of these codes follows:

1 The test code covering insulation in the building and low-temperature field has been reviewed for the last time by the Sub-Committee dealing with this subject. As soon as it has been prepared editorially it will be printed and given wide publicity.

2 A similar test code covering insulation in the steam and moderate-temperature field has been finally reviewed by the Sub-Committee having it in hand, and will be published in the manner indicated above.

3 The Test Code Committee covering high-temperature insulation is cooperating with a committee of the American Society for Testing Materials in the preparation of a code in the high-temperature field.

4 The Test Code Committee covering electrical insulation has presented a tentative report. However, as the experimental determination of the thermal transmittance of electric cables has not been attempted prior to this time, the committee deems it advisable to conduct some further research on this section of the code prior to its publication. In this connection it is gratifying to announce that the Brooklyn Edison Company, the New York Electrical Testing Laboratory, and the General Electric Company have arranged to immediately undertake this costly but much needed work.

It is confidently expected that the use of these codes standardizing both the design of testing apparatus and laboratory procedure will provide the engineering profession with more accurate information on the thermal conductivity of insulating materials, and will eliminate certain inconsistencies which are very evident in this field of heat transfer.

d The Committee is also sponsoring from a technical point of view the preparation of two comprehensive texts, one on the "Promotion of Heat Transfer," by Prof. W. H. McAdams, and the other on "Heat Insulation," by L. B. McMillan.

While the work of compilation is being undertaken by the chairmen, two of the leading authorities in the country in their respective subjects, the criticism and revision of this text will be in the hands of the entire committee on each subject, who are specialists from all parts of the United States, and from industry as well as colleges.

It is expected that this work, which will be fully completed within the next two years, will be as nearly authoritative as present-day experimental and mathematical research permit, and will do away with many of the contradictions and much of the confusion that exist in the data available to the engineer at the present time. It will also point out definitely what is known and what is not known, so that future experimental research can be concentrated on those problems, the solution of which is most urgent.

e In the important field dealing with the promotion of heat transfer (Sub-Committee A), the Committee has authorized the establishment of three research fellowships of two years each in three selected educational institutions, provided the necessary funds can be raised. The objective in undertaking this work is the experimental determination of the laws relating the rate of heat transfer to the physical properties of liquids and their vapors, among which might be mentioned viscosity, thermal conductivity, and specific heat, both in heating and cooling and in the liquid and vapor phase. This will represent a masterpiece of fundamental research and is of the greatest importance both to the manufacturer and user of equipment such as oil and water surface condensers, feedwater heaters, ammonia condensers, intercoolers, oil and water heat exchangers, and the like. The cost will approximate \$3000 for three complete sets of apparatus, and from \$6000 to \$9000 for the fellowships over the two-year period mentioned above, which will be in addition to the requirements of our normal annual budget.

In addition to this, all laboratory facilities, including the assistance of observers and scientific measuring instruments, will be provided gratis by the university at which the fellowship is established. The cost of this, if done as individual research work by private individuals, would represent an expenditure of at least \$75,000, thus making available to industry, for a nominal sum, information that would hardly warrant its cost if undertaken by any single company.

It should be stated that Sub-Committee A (Promotion of Heat Transfer) has definitely formulated the details of this problem and the members of the Committee have designed the apparatus to accomplish the desired result.

f In view of the fact that heat transmission by radiation is such an important aspect of the general subject, a conference of leading authorities will be held early in 1929 for the purpose of determining the present status of our knowledge of the laws of heat transfer by radiation, and also to arrange for additional experimental research to fill the very evident gaps which are known to exist in our present engineering information and data in this field.

In closing, the author of this paper desires to express the appreciation of the Committee on Heat Transmission to those who are so ably supporting its activities from both a scientific and financial standpoint.

Properties of Chromium Plate

ELECTRODEPOSITED chromium is used in thick layers for wear resistance in automobile parts, and in stamping dies, extrusion dies, roller faces, and plug gages. Two characteristics fit it peculiarly for such service, namely, hardness and its smoothness. The following table of comparative scratch hardness will give a fair idea of the hardness of a chromium plate as compared with other metals:

Chromium in electrodeposited plate	2000
Case-hardened steel	1950
Steel shafting	750
Swedish iron	408
Bronze	244
Babbitt	208
Copper	78

The greatest defect in thick coats of chromium is a pronounced tendency for the metal to crack when struck a blow or when a varying load is applied to it.—R. Schneidewind in *The Iron Age*, Mar. 7, 1929, p. 670.

Boiler-Furnace Refractories

Outstanding Results of the Refractories Research Now in Progress—Notes on Papers on a Test Furnace, Air-Cooled Furnace Walls, Slag Removal, Etc., to Be Presented at the A.SM.E. Rochester Meeting This Month

By C. F. HIRSHFELD,[1] DETROIT, MICH.

THE A.S.M.E. Special Research Committee on Boiler-Furnace Refractories was organized in 1925. There had grown up a general recognition of the fact that there was not available sufficient information regarding either the conditions to which boiler-furnace refractories were subjected in use or the characteristics of such refractories to enable power-plant engineers to use them advantageously. With the service demanded becoming continually more severe, it appeared that such research might yield commercially valuable information.

The program that was adopted is a lengthy one and contemplates research extending over possibly five to eight years. It was prepared as a result of conferences with producers, users, and ceramic engineers, and an effort was made to devise a research which should yield valuable and usable information from the very beginning, and which, when completed, would put both manufacture and use of refractories for boiler furnaces on a rational and scientific basis. Progress reports have been published from time to time in MECHANICAL ENGINEERING and elsewhere, so that the industry has been kept informed of such progress as has been made.

The first part of the work was directed toward an accurate determination of the actual conditions to which refractories are subjected in boiler furnaces. This was accomplished by means of an extensive and painstaking survey of typical boiler plants. The work was done by members of the staff of the U. S. Bureau of Mines, with which bureau a cooperative agreement had been made. The survey included furnaces of various sorts burning fuels of different sorts in different ways. Measurements and tests were made to determine typical values of what were believed to be the principal controlling factors with respect to service rendered by the refractories. These included the temperatures of the fire faces of the refractories, the temperature gradients through the refractories, the compositions and temperatures of furnace gases near the refractories and at other points in the furnaces, amount and character of ash carried in suspension in the furnace gases, and differences in the composition of ash in different parts of the assemblage, as well as many other significant factors.

Need for Study of Fluxing or Slag-Forming Phenomena

It is interesting to note that this survey confirmed certain ideas that had been held by a few engineers before it was undertaken but which were contrary to very widely accepted belief at that time. When this work was started a number of the refractory manufacturers were beginning to make and market "super refractories," by which term was meant refractories with very high softening or melting temperatures. The survey showed very plainly that the actual temperature of the furnace face of the refractory is of such an order that it falls well below the melting temperature of any reasonably good refractory. Wastage of the type which had commonly been assumed to be due to melting of the refractory was shown to be due to the melting of a slag formed by chemical combination of ash and refractory and having a lower melting point than the refractory. The slag may cause wastage by becoming sufficiently liquid to flow readily, or the wastage may be caused by the erosive action of high-velocity gases flowing over such molten slag. Obviously these findings indicate the necessity for studying these fluxing or slag-forming phenomena, rather than the introduction of more "refractory" products which might conceivably flux even more readily with a given ash.

This survey also confirmed the belief that air-cooled refractories in which air penetrates the refractory of the wall and enters the furnace give results not only through cooling of the refractory but also through the creation of an oxidizing atmosphere, or at least a less-reducing atmosphere, on the fire side of the wall. The creation of such an atmosphere raises the softening point of the refractory and of the slag formed with it by action of the ash.

It was also shown that the cooling effect of water-cooled walls extends only a comparatively short distance into the furnace at the places in which intense combustion is occurring. The maximum distance appears to be something of the order of 18 to 24 in.

Only a few of the outstanding results of the survey have been mentioned. All have been published, and an engineer who has familiarized himself with them is now in position to effect real savings in the use of refractories, even though this work represents only the beginning of the research program.

Desirability of a Simple and Inexpensive Test

The great importance of wastage and failure of refractories due to the fluxing action of the ash and the creation of a low-melting-point slag, early convinced the Committee that a simple and inexpensive test which would determine the relative values of different bricks in resisting this action with a given ash would have great commercial value. A study of the various trials that had been made and of many suggestions that had been offered led to the decision to enter into an agreement with the Ceramics Department of the University of Illinois for the development and proof of one type of equipment. After certain early difficulties had been overcome, Professors Parmelee and Hursh of that institution developed a test furnace and allied equipment which has now had rather extensive tests. The results given by this furnace on certain bricks and certain coal ashes are being compared with the results reported in the survey for cases in which the same combinations were used in real boiler furnaces. Thus far the laboratory equipment has shown rather remarkable ability to duplicate field results. A full account of the design and operation of this furnace and of the results obtained thus far is given in a paper to be presented by Prof. R. K. Hursh at the Rochester Meeting.

If this furnace and method of test prove to be as good as present indications would lead one to believe, a very valuable tool is made available for the study of fluxing or slagging action. With it, it will be possible to determine readily the effect of different degrees of grinding of raw materials, different compositions, different methods of forming, and different methods of burning. It should therefore be possible to specify for trial in real boiler furnaces, burning different fuels, those bricks which stand the greatest possible chances of giving satisfactory performances. The Committee plans just such a program.

[1] Chief, Research Department, Detroit Edison Co., Mem. A.S.M.E.

Meanwhile it is appreciated that if we had sufficient knowledge of the physical chemistry involved, we could predict a great deal from the chemical composition of the brick and of the ash with which that brick is to be used. Conversely, we should be able to specify that chemical composition of brick which may be expected to give the best results with a given ash. Such knowledge is not now available, and the Committee believed that it should be made available. For this reason a cooperative arrangement has been entered into with the U. S. Bureau of Standards Ceramic Laboratory at Ohio State University, Columbus, for the development of the necessary data. Comparisons are being made between the minerals found in the slagged end of bricks from operating boiler furnaces and the bricks from the test furnace at Illinois. In this way the minerals actually produced in use are being identified and classified with respect to the conditions of service, and the degree to which the Illinois furnace duplicates actual conditions is being determined.

In addition the laboratory at Columbus is determining the temperature-equilibrium diagram of the four-component system including the principal oxides that enter into the formation of these minerals. This work is highly technical and has involved the development of equipment and methods. It is progressing very satisfactorily and results of value will be published shortly.

The investigations in progress at Columbus are described in a paper to be presented at the Rochester meeting by Messrs. T. A. Klinefelter and E. P. Rexford under the title "A Study of Crystalline Compounds Found in Slags on Boiler-Furnace Refractories."

While all this work is going on we must continue to purchase and use firebrick, and we naturally want to purchase as advantageously as possible. This involves the use of specifications of some sort for what they may be worth. At present their greatest value appears to lie in the enumeration of tests and methods by means of which material received can be checked for conformity with material previously used or previously tested. A paper on "Boiler Refractory Specifications," by S. M. Stuart and J. Spotts McDowell, which is to be presented at Rochester not only reviews presently available specifications but includes a lot of original test data to illustrate the degree of accuracy and the limitations of test methods now in use.

The very rapid increase in the use of suspended and air-cooled refractory walls and the satisfactory results that are being obtained with many of the designs now marketed make these constructions of particular interest to engineers interested in the general subject of refractory furnace walls. For this reason a paper by C. S. Gladden on "Proprietary Air-Cooled Walls" has been included in the Rochester symposium. The action of these walls is of particular interest to the Boiler-Furnace Refractories Committee, because their behavior is in many respects quite different from that of the old form of refractory wall.

In addition to the papers already mentioned there are also to be presented two on the removal of ash in the molten condition from pulverized-fuel-fired furnaces. These are respectively a paper entitled "Evolution of the Slag-Tap Furnace at the Charles R. Huntley Station of the Buffalo General Electric Co.," by C. M. Cushing, and "A Study of Some Factors in Removal of Ash as Molten Slag from Powdered-Coal Furnaces," by R. A. Sherman, P. Nicholls, and Edmund Taylor. These papers are not only interesting because of the information they give regarding a radical, new, and exceedingly promising method of handling a troublesome problem, but also because the slagging of ash in such furnaces brings in interesting refractory problems and is also closely associated with the wall-slagging problems of other furnaces.

pH

THE symbol heading this article has come to have important significance in many lines of industry. It has to do with the control of acidity in industries in which what might be called the "active acidity" is of importance. Examples are found in fermentation, dyeing, tanning, laundering, baking, and in the manufacture of sugar, candies, gelatin, and paints. The active acidity of a solution is often but a small fraction of its total acidity, just as the standing army of a nation is often but a small fraction of its total man power. The fact that strawberries usually taste more sour than tomatoes indicates that they have a higher active acidity; yet the total acidity of tomato juice, as measured by the amount of soda required to neutralize it, is often higher than that of strawberry juice.

The symbol pH is derived from "potential of hydrogen," since the most accurate method for determining the active acidity employs an electrometric apparatus, with a hydrogen electrode. As active acidity falls off, the pH increases, one unit for each tenfold decrease of acidity. Thus a pH of 5 means but 10 per cent of the active acidity of a pH of 4, and but 1 per cent of that of a pH of 3. Neutral solutions have a pH of 7, and alkaline solutions greater than 7.

Within the past few years the complicated electrometric methods for determining active acidity have been largely replaced by more convenient though less accurate methods that take note of the colors presented by standard indicators in the solutions to be tested. The result has been the employment of determinations of active acidity, that is, of pH, in many industries that were formerly content with determinations of total acidity. In the refining of cane sugar and glucose pH control has resulted in superior products and increased yields. The consistency of fondants and cream fillings in candies is dependent on the active acidity during the boiling operation, and thus calls for pH control. The same is true of the baking of flour, bread, etc.

The working properties of solutions of gelatin and glue depend to a considerable extent on the pH of their solutions. Gelatin has points of maximum swelling at pH = 2.4, and pH = 11.6, and minimum swelling and minimum adhesiveness at pH = 4.7. In water purification the best results are obtained in coagulation and filtration if the pH value of the water is correctly adjusted. The proper value varies with the type of purification and filtration effected, but can readily be determined. Costs of freeing liquids from sediment by filtration may frequently be cut in half by control of the active acidity of the solution. The $20,000,000 sewage-disposal plant of Milwaukee could not operate without careful pH control.

The corrosive effect of water depends largely upon its pH value, other factors being the same. The importance of pH control in the chemical treatment of boiler feedwater is therefore apparent. The acidity of soils is an important factor in the corrosion of underground piping and can readily be ascertained in the field by a pH determination. The most favorable condition of a soil for plant growth is usually obtained when its pH value is between 6 and 8. Human blood normally has a pH of about 7.5, namely, is very faintly alkaline.

In the differential flotation of ores pH control is being used by practically all the large mining companies. In nickel plating many of the troubles have been traced to improper acidity of the bath. Even slight changes cause marked effects on the appearance or properties of the nickel deposit. By pH determinations a close control of the bath is obtained. The same is true of zinc plating. It has also been found that pH control is an important factor in the production of pigments such as lithopone, blanc fixe, and satin white.—Industrial Bulletin of Arthur D. Little, Inc., March, 1929.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

AERONAUTICS (See also Engineering Materials: Reynolds Tubing for Aircraft)

The Cross-License Patent Agreement of Dec. 31, 1928

THE first cross-license patent agreement in the aircraft industry was entered into in 1917, with the stated purpose of preventing patent litigation which might have retarded the production of aircraft for national defense. In December, 1928, a new agreement was signed covering the more important aircraft-manufacturing concerns and recognized by the War and Navy Departments. Under this agreement a certain royalty is to be paid by the subscribers of the association, beginning with $25 per plane for the cheaper planes and increasing with the cost of the plane to a maximum of $200. The primary function of the association is stated to be to act as an agent for the parties to the cross-license agreement in executing prescribed licenses, collecting and distributing royalties, and appointing through its board of directors one of the arbitrators to pass upon the value of patents acquired subsequent to the execution of the agreement. Nothing is stated in the article as to how the money collected is distributed. The remainder of the article contains a defense of the legality of the association from the point of view of the Sherman anti-trust law and Clayton act. (Lt.-Col. Joseph I. McMullen, Judge Advocate General's Dept. in charge of War Dept. Patents, in *Aviation*, vol. 26, no. 10, Mar. 9, 1929, pp. 728–729, *g*)

The Fairey Long-Range Monoplane

THE British Air Ministry has released only a certain amount of information about this machine. It is known, among other things, that it is a pure cantilever monoplane with wings varying throughout the span in thickness, chord, and incidence. The tail is also a cantilever, the only external bracing wires being those used to support the fin. Special internal bracing is used to prevent twisting of the wing during maneuver. The engine is a Napier-Lion. The machine carries more than 1000 gal. of fuel in the wings, feeding by gravity to a collector tank under the floor of the cabin, whence it is pumped to the engine. A wind-driven pump is available for emergency purposes.

From photographs it would appear that the wing span, which is given as 82 ft., is very large in proportion to the cross-section of the fuselage. The main chord is given as 11 ft., which would give a total wing area of 902 sq. ft. This is a very large area for a monoplane, and probably indicates that although the power loading at the start may be fairly high, the wing loading most likely is not unduly so. (*Flight*, vol. 21, no. 5/1049, Jan. 31, 1929, pp. 77–81, illustrated, *d*)

The "Helioplane"

THIS machine, which is claimed to rise vertically from the ground, is the invention of John E. Hess, of New Westminster, B. C.

The working model is equipped with two 9-ft. propellers made of drill cloth, cedar sticks, and wire. It weighs 530 lb. and is equipped with an old Lawrance two-cylinder 28-hp. airplane motor. In the first test the motor was permitted to develop a considerable amount of power and wrecked the blades of the machine. New propellers were constructed and have been held to a maximum of 200 r.p.m., at which rate they are said to lift the 530 lb. weight with ease. The lifting power is furnished by two duralumin propellers, which are the characteristic feature of the invention.

They are fastened on vertical shafts and, when in action and viewed from the front, rotate inward. Each propeller has its blades set at an angle of about 15 deg. The blades are hinged and the trailing edges hang down when the plane is stationary. When it is ascending the blades are horizontal. But even when the machine begins to descend the resistance of the air elevates the trailing edges, transforming the propellers into parachutes which check the rate of the downward flight.

Between the propellers is a large stabilizing fin which will counteract any tendency of the machine to sideslip when traveling in "bumpy" atmosphere, or when descending vertically with the propellers stationary. The upright supporting this fin is hollow and contains a large parachute which can be released by the aviator to check his descent in case of accident to the propellers. The machine is so designed that the center of gravity is directly below the base of this upright, thus making it impossible for the helioplane to tip sideways or reach the ground in any way but an upright position.

The machine has apparently been operated only in its shed. (Frederick H. Fullerton in *Canadian Aviation*, vol. 2, no. 2, Feb. 1929, p. 20, *d*)

Crude-Oil or Gasoline Engines

THIS subject was informally discussed at a recent dinner of the Royal Aeronautical Society. Complete discussions of subjects at these dinners are not published, and only an edited abstract is available.

Among the advantages of the compression-ignition engine advanced by Wing-Commander Hynes, particular stress was very naturally laid on the increased fuel economy, and it was pointed out that in making the comparison one should count in the engine and its fuel. If that were done, it was found, according to a graph prepared in 1927 by Mr. Taylor of the R.A.E., that after some six to ten hours' flight the compression-ignition engine began to show a lower weight than the gasoline engine.

Captain Wilkinson disagreed on this point, using the argument that in making the estimate no account had been taken of improvements in the fuel consumption of the gasoline engine. In point of fact, a gasoline engine, a rather special one certainly, had shown a full-power consumption as low as 0.41 lb. per hp. per hr., while at three-quarters throttle the consumption was as low as 0.31 lb. per hp. per hr. No compression-ignition engine had so far reached such low figures. Moreover, the compression-ignition engine required larger cylinders for the same power, and this increased both size and weight, factors which in turn reacted on the aircraft.

Captain Irving, the designer of Major Segrave's racing car, and Mr. Fedden, designer of the Bristol aero engines, both advanced the views that, given sufficient encouragement, the compression-ignition engine could be developed, Mr. Fedden expressing the opinion that if the capital necessary for development were forthcoming there was no reason why, in three years' time, a 1000-hp. compression-ignition engine should not be produced having a re-

liability as great as that of the gasoline engine. His estimate of the weight, under these conditions, was 3 lb. per hp.

Major G. P. Bulman pointed out that with the small nozzles and rather delicate pumps required by compression-ignition engines, the fuel specification for the heavy oil would have to be quite as carefully designed as that of the present-day gasoline.

Tempting as looks the possibility of being able to burn, in our aircraft engines, fuel costing some £5 per ton, one should not lose sight of the fact, as pointed out during this discussion, that as soon as the demand for crude oil increases as a result of general use, the price will certainly go up, and the present price difference will tend to be greatly reduced. Consequently we think one should not stress too much the question of relative cost. Rather should one look to other factors for weighing up the pros and cons of the two types of engine. To us it seems that both types will undoubtedly have their uses. For airship work, for instance, the compression-ignition engine will undoubtedly score. Airships are preeminently long-distance craft, and consequently the greater initial weight of the compression-ignition engine is soon outweighed; that is to say, if one counters Captain Wilkinson's argument by assuming that his special gasoline engine of low fuel consumption may have its counterpart among the compression-ignition engines. The question of fire is also an important one, and it is usually claimed that the heavy oil is less dangerous than is gasoline, as it gives off no vapor at ordinary temperatures. (*Flight*, vol. 21, no. 5/1049, Jan. 31, 1929, pp. 75–76, *c*)

ENGINEERING MATERIALS

The Relative Safeties of Mild and High-Tensile Alloyed Steels Under Alternating and Pulsating Stresses

A DISCUSSION of the general subject of fatigue strength, bringing out as one of the results of practical importance the fact that a material stronger in tension may prove to be more likely to fail under certain stresses, resulting in fatigue.

Different authorities have stated that 90 per cent of the fractures that result in breakdowns in service are attributable to fatigue; and although this proportion may perhaps be overstated, there is no real doubt that fatigue cracking is in fact one of the most common causes of fracture in service.

The standard scantlings and "factors of safety" in general use among engineers today are based largely on experience of mild steel, which has proved itself one of the most reliable of metals, and a very good friend to the engineer and shipbuilder. It should not be assumed hastily that the same "factors of safety" are necessarily suitable when other metals are used.

To compare the effects of different stress cycles it is convenient to regard any cycle as made up of two components, namely, a mean "steady" stress and an "alternating" stress. The author then gives a diagram in which the fatigue limits are represented for different values of both kinds of stresses. He points out that it is only when the fatigue line falls below the yield line that there is any particular danger of fatigue. (Fig. 1.)

The mild steel (represented in the diagram on the left) is taken as having an ultimate tensile strength $u = 30$ tons per sq. in. and a yield point $y = 21$ tons per sq. in. The ordinary fatigue limit has been taken as $a_0 = \pm 18$ tons per sq. in., this being 60 per cent of the ultimate, and the fatigue line has been drawn as a parabola, corresponding to index $n = 2$. All these conditions are favorable to safety as regards immunity from fatigue; and in the diagram this safety is illustrated by the exceedingly small peak of the 45-deg. triangle that is shaded where it appears above the fatigue line. In such a metal fatigue must necessarily be an uncommon experience. Fatigue can occur only when the steady stress is so small and the alternating stress so precisely regulated that the point representing the combination remains within the shaded area long enough to produce a crack. Only when the stress alternates between extreme values that are almost exactly equal is it possible to enter the shaded fatigue zone. In any other circumstances the metal yields and thereby gives warning—often, although not always, without danger—long before there is any risk of cracking under long-continued variation of stress.

In laboratory tests on mild steel, fatigue is readily demonstrated, and the risk of fatigue is sometimes exaggerated, because the steady stress can be—and usually is—exactly equal to zero. But even in laboratory tests a mild steel, such as that represented in the diagram, will exhibit fatigue only if the alternating stress is carefully adjusted and the steady stress is nearly zero.

In such circumstances, not always clearly appreciated, it is

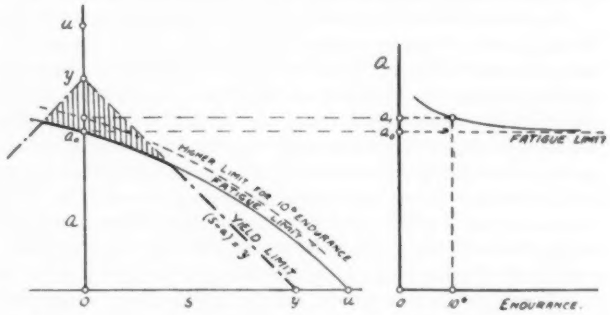

FIG. 1 SHOWING HOW THE FATIGUE LIMIT a VARIES WITH s

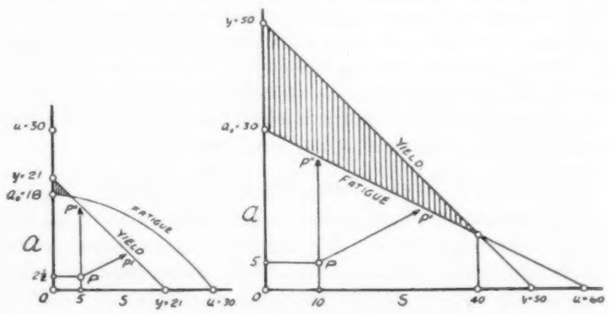

FIG. 2 CONTRAST BETWEEN MILD STEEL (LEFT) AND HIGH-TENSILE STEEL (RIGHT)

little wonder that many engineers and shipbuilders having experience of mild steel have formed the opinion that fatigue is a timid creature that seldom ventures outside the walls of a laboratory, and is rarely dangerous in practical experience. In practice, they say, ships and bridges can be designed with reference to "static" or "yield" strength alone, without troubling unduly about the slight possibility of fatigue. Although it will be shown in the concluding section of this paper that this attitude of confident security is not always fully justified, it is not often unsound.

The second diagram in Fig. 2 illustrates the very different relations that commonly prevail in high-tensile steels, and explains why fatigue is often an important source of danger with such steels.

The ultimate tensile strength has now been taken as $u = 60$ tons per sq. in. and the yield point as $y = 50$ tons per sq. in.—relatively higher than in mild steel. The ordinary fatigue limit has been taken as $a_0 = 30$ tons per sq. in., this being 50 per cent of the ultimate tensile strength—a value that may be regarded as satisfactory in steels of this class. The fatigue index n has been taken as unity—perhaps somewhat on the low side, but not unreasonably so. The values have been assumed for comparative purposes without reference to any particular brand of steel.

It is at once evident that that dangerous fatigue zone, shaded in

the diagram, is relatively larger than before; and also that a relatively longer part of the "safe" area is bounded by the fatigue line instead of the yield line. In the case illustrated fatigue can occur—without any premonitory signs of yielding—under any value of stready stress up to 40 tons per sq. in. And further, a large part of the shaded area is so wide that fatigue can be produced quickly—during a very few minutes—by excessive ranges of alternating stress well above the ordinary fatigue limit. In such metals, therefore, fatigue is no longer a remote possibility for worn-out engines, but an immediate danger in trial runs on new machines.

The comparison between the two diagrams clearly shows that the high-tensile steel is indeed the stronger and therefore the safer, if the applied stresses are the same and the dangers of yield and fatigue are regarded as identical. The "safe" area in the diagram for the high-tensile is somewhat higher and much wider than the "safe" area for the mild steel. The high-tensile steel is therefore able, without fatigue, to do all the mild steel can do without yielding, and something more. But it is not advisable to work the two steels with the same "factors of safety" reckoned on the ultimate tensile strength.

The author proceeds next to calculate the behavior of two plates—one made of high-tensile and the other of mild steel, with or without drilled holes. He finds that the drilled mild steel is actually 20 per cent stronger than a drilled plate of high-tensile steel, notwithstanding the fact that the latter is 100 per cent stronger in ultimate tensile strength than the former, 138 per cent stronger in tensile yield, and 66 per cent stronger in "ordinary" fatigue tests where equal pull and push stresses are used. In such circumstances it is not surprising that many practical men look with suspicion upon incomplete test figures. The lesson of the above contrast has been verified by experiment (references in the original article). Among other things the article describes the Haigh electromagnetic machine for alternating-stress testing. This machine employs alternating-current magnets and has means provided for carrying out tests with loads that alternate between unequal values of pull and push or pulsate wholly as pull or as push. (Prof. D. P. Haigh, in a paper read at the meeting of the Chemical Engineering Group on Jan. 11, 1929; abstracted through *Chemistry and Industry*, Journal of the Society of Chemical Industry (England), vol. 48, no. 2, Jan. 11, 1929, pp. 23–30, 8 figs., *cetA*)

Reynolds Tubing for Aircraft

THE Reynolds Tube Co., Ltd., at Tyseley-near-Birmingham, is one of the largest manufacturers of metal tubing for aircraft. The present article tells the history of the company, together with particulars of some of the methods used.

The hardening and tempering of these tubes presented many difficulties, especially because the most difficult of all, the $2^3/_4$-in. × 20-gage, were required in many cases in 13-ft. "dead" lengths.

The ideal method of hardening and tempering, no doubt, is a vertical furnace from which the tubes could either be lowered or raised, for air hardening. But as the expense of such a furnace capable of attaining and maintaining a temperature of 850 deg. cent. was out of the question, other means of preventing distortion had to be found. The furnace available (which was specially designed for "bluing" and heat treatment of tubes to aircraft specifications) is heated by coal gas, and has a mechanical side-feed and discharge apparatus working along its 20-ft. length.

At the very beginning it was found that the tubes assumed an oval shape if heated to a temperature of 850 deg. cent. while stationary on the floor of the furnace, and that the charging apparatus damaged the tubes when discharging for air hardening. This difficulty was overcome in the following manner. The charging apparatus was dismantled from the furnace, leaving a level carborundum floor, over which the tubes were rolled one at a time by two men with hooked rods threaded in each of the tubes. It took from five to ten minutes for the tubes to reach a temperature of 850 deg. cent. They were then lifted out by means of the hooked rods, and immediately placed on the level floor by the furnace and continuously rolled there until cold. By this method the tubes are kept reasonably straight and comparatively round.

To obtain the mechanical properties required (65 proof stress) tempering was done at a temperature of 400 deg. cent., when the tubes were rolled on the furnace floor in the same way as for hardening.

The following dimensional limits were required: Straightness with 600/length and roundness within ±2 per cent of the diameter. The roundness was obtained by careful "reeling" and pressure. The straightening, however, was not so simple, as the tubes usually took a fairly sharp "set" near the ends.

It was found that the tube collapsed before it would straighten, so to overcome this difficulty it was necessary to load the entire tube with resin, which when cool resisted the crumpling effect of straightening. Afterward the resin had to be melted out. But occasionally the resin caught fire, and in effect it tempered the tube below the required strength, and then the whole process of hardening, tempering, loading, and straightening had to be done again.

Owing, however, to the experience of the firm, many of the difficulties first encountered have been overcome, and the production of such tubes as a commercial possibility is in sight. It must be pointed out, however, that the cost of these operations must necessarily make the price of such tubes high. With regard to the testing of these tubes, it is impossible of course to test them as batches, and many of the tests have to be taken on each tube.

The same company is manufacturing manganese-steel tubing in two analyses, both containing 1.5 per cent manganese, but with varying contents of carbon, one having a maximum carbon content of 0.30 per cent and the other of 0.50 per cent. The presence of manganese is said to have increased the strength of the steel and improved its welding properties. Specifications of steels of various kinds for tubing are given. (*The Aeroplane*, vol. 36, no. 4, Jan. 23, 1929, pp. 130, 132, and 134, 3 figs., *d*)

Rubber-Structure Research

PROFESSOR KATZ in his first publications assumed some kind of "crystallization" of rubber during stretch, while Mark and the present author favor the idea that the molecular aggregates are preformed but in a swollen condition and therefore not suitable for X-ray interference. X-ray research on cellulose has, however, shown its structure. Rubber when racked is in many of its properties closely related to fibrous materials. From a study of the models of its structure the author arrives at the conception that a certain stretch is needed to produce a sufficient number of identity periods to obtain interference. The author goes as far as to say that we can postulate that all fibrous materials are built up of main valency chains bundled together by micellar forces to form parcels of parallel chains, only the length of the chain and the number per parcel are not yet ascertainable with great accuracy. Furthermore we can say that their elasticity will depend largely on the form of the smallest element, be it a ring as in cellulose or a straight chain as in rubber, and especially on the actual helix angle. The appearance of X-ray fiber diffraction patterns depends on the condition of these chains—i.e., whether swollen or not; for example, stretched rubber in contact with solvent vapors loosens the pattern, as do alkali-treated cellulose and celluloid. Celluloid is a perfect analogy to rubber, giving an "amorphous" scattering in unstretched condition, inasmuch as the nitrocellulose has been swollen by the added camphor. Brown, however, has recently shown that celluloid when stretched

sufficiently will show the original nitrocellulose pattern, the camphor having been expelled out of the fiber structure. Furthermore, with any material there is a relation between the ratio of plastic internal flow and elastic stretch. Whenever the latter can compensate the former and this state can be maintained sufficiently long and where the viscosity of the lower polymerized phase is not such that it prevents orientation by ordinary means, thus producing an inelastic or very slightly elastic product as in the case of many resins, we shall obtain a similar X-ray diffraction pattern. (E. A. Hauser, Assistant Professor of Colloid Chemistry, Massachusetts Institute of Technology, in *Industrial and Engineering Chemistry*, vol. 21, no. 3, Mar. 1, 1929, pp. 249–251, *t*)

FUELS AND FIRING

Pulverized Fuel for Steam Raising in Great Britain

THE drying of coal before grinding has long been, quite unexpectedly, one of the most difficult problems of pulverized-fuel firing, and the general trend in this connection, as represented by the work of 1928, is the elimination of both the vertical gravity and the rotary cylindrical drier, as well as the principle of using heated gases of combustion, whether from the boiler setting or otherwise. Low-pressure steam has proved in general to be more satisfactory, with recovery of the hot condensed water, and an important new type of drier is a large vertical metal cylinder with a series of transverse compartments, short in height, having steam-heated floors and slow-moving rabble arms, the coal entering at the top and passing down and round through each compartment in turn. Also highly important is the principle, for coal with moderate moisture content and high in "rank" or geological age, of passing heated air direct through the pulverizers in circuit with the air heaters, burners, and combustion chambers, thus eliminating to a large extent the use of separate driers. Further, in connection with pulverizing, the importance of uniform grinding and the absence of even a small proportion of large particles is now fully recognized, while the centrifugal pulverizer with gravity separation by means of a current of air grows in favor and continues to increase in size.

Undoubtedly one of the most important achievements of the past year is the effective development of practical types of "turbulent" short-flame burners. Much rubbish, of an obviously inspired character, has appeared in the press of late on the subject, and it should be emphasized that an efficient type of short-flame burner operated with low air pressure and power consumption is not complicated as regards adjustment and control, and will take continuously a large amount of coal without deterioration by the heat. Also it may be remarked in this connection that any low-temperature-carbonization fuel, as turned out by many processes, is very suitable for use whether on land or sea. Several burners of proved, good quality have been definitely established during the past twelve months, and the subject is of the utmost importance, both as regards reducing the size of the combustion chamber in the case of water-tube boilers and facilitating the application of pulverized-fuel firing to cylindrical boilers. Further, with regard to burners, the "screw" type of feeder for pulverized coal is beginning to be regarded as obsolete largely because of the tendency to "jamming" and irregularity of supply.

Of great significance for all types of steam generator is the notable progress that has been made recently with the "unit" pulverizer, i.e., self-contained apparatus carrying on within itself the operations of partial drying, and all or part of the air supply. As regards cylindrical boilers, the year 1928 is noteworthy in the history of pulverized-fuel firing because voyages under actual commercial conditions, as well as long-continued experimental work, have proved that this method of firing can be termed a practical proposition for Scotch marine boilers. (David Brownlie in *The Iron and Coal Trades Review*, vol. 118, no. 3178, Jan. 25, 1929, p. 121, *dp*)

INTERNAL-COMBUSTION ENGINEERING (See also Aeronautics: Crude-Oil or Gasoline Engines: Motor-Car Engineering: The Deguing- and Two-Stroke-Cycle Motor)

Gas-Operated Internal-Combustion Engines

THE article under consideration describes the methods of carbureting and storing the gas used as fuel for internal-combustion engines on the Paris buses.

The gas is carried under pressure either in ordinary containers (Fig. 3) connected in parallel to a high-pressure line *B* which has a stopcock at each end, *C* for charging and *D* for discharging. A membrane-type expander *E* is placed between the line *B* and the carburetor *F*. It is absolutely necessary that when the motor stops there should not be a high pressure produced in the low-pressure compartment, which might happen as a result of some

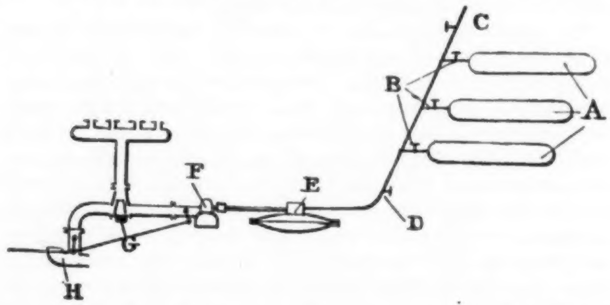

Fig. 3 Gas-Fuel Storage and Manifolding on the Paris Buses

leak and would lead to a quick destruction of parts not built for high pressure. A safety valve has therefore been provided consisting of a thin rubber membrane held in place by a metallic annular member which can be easily replaced. Back of the gas carburetor *F* there is a three-way valve which permits to connect the suction of the motor with a gasoline carburetor *H* so that the motor can be supplied either with gasoline or with both fuels at the same time. Preliminary tests with city gas have shown a thermal efficiency 10 per cent better than that produced by gasoline. This result is ascribed to the greater uniformity of the carbureted mixture, elimination of condensation of fuel in the admission piping, and ability of the gas to stand higher compression ratios. (*Le Genie Civil*, vol. 94, no. 8, Feb. 23, 1929, pp. 195–196, 2 figs., *d*)

The Bro-Hawk Two-Stroke Double-Piston Engine

THIS is a peculiar type of internal-combustion engine working on the two-stroke cycle but carrying pairs of power cylinders side by side, these pairs being operated as a single compression and expansion chamber. The two cylinders communicate at the top, while the two pistons in each pair of cylinders are connected through short connecting rods to the T-head on the main connecting rod. The result of this arrangement is that the two power cylinders are in phase only at the top and bottom of the stroke, while at the intermediate positions one piston leads the other.

The engines operate on the supercharging principle, the supercharging being effected by means of a piston-type pump whose piston is connected to the upper end of the main connecting rod, and works in a bore below and symmetrical with the two power cylinders. In the actual engine three pairs of working cylinders are used with the cranks set at 120 deg. There are no valves,

their functions being performed by the pistons in conjunction with ports in the cylinder walls.

It is stated that at least two engines have been built on this principle. The Diesel engine has been operated at speeds up to 2000 r.p.m., and the gasoline engine up to 3000 r.p.m. It is stated that the engines operate without perceptible vibration at speeds of 1200 and 1500 r.p.m., respectively. Reports of tests made by H. Moren, a Swedish engineer, are given. From these it would appear that the Diesel-type engine developed 49 b.hp., with a fuel consumption of 0.50 to 0.55 lb. per b.hp-hr. at 32 hp. at 1100 r.p.m. The gasoline engine developed 38 b.hp. at 1500 r.p.m. and showed a fuel consumption of 0.77 lb. per b.hp-hr. with ordinary gasoline. (*Automotive Industries*, vol. 60, no. 7, Feb. 16, 1929, pp. 244–245, 2 figs., *d*)

MEASURING APPARATUS

An Electrical CO_2 Meter and Aspirator

THIS is a measuring unit which combines the Shakespeare katharometer used as a CO_2 meter, with a Cambridge electrical CO_2 indicator and recorder. The meter is here combined with a bubbler-aspirator in one complete all-metal unit. Complete compensation for water vapor is obtained by bringing the gases on both sides of the meter to saturation at the temperature of the meter block. It is claimed that the symmetry of design eliminates temperature gradients through the meter, and that rubber seatings are reduced to a minimum throughout the system.

In the tests it was found that the maximum zero shift produced was 0.5 per cent CO_2, and that only under extreme conditions of supply-water temperature not likely to be found in a boiler house. With all the water and air temperatures likely to be encountered on a boiler plant the meter zero shift was negligible.

Further tests showed that there was practically no risk of CO_2 leaking into the compensator cell from a contaminated atmosphere, and thereby causing spurious readings, and also that there was no likelihood of interference with the meter readings due to water condensation inside the meter. (*Engineering and Boiler House Review*, vol. 42, no. 8, Feb., 1929, pp. 415–416, 1 fig., *d*)

METALLURGY

Sulphide Segregation in Steel

APART from some instances segregated steel can rarely be used in a satisfactory manner, and a considerable number of fallacies can be attributed to sulphide segregation. What is more, when steel is purchased on specification involving chemical analysis, segregated steel examined in this way may show percentages of sulphur varying clearly with the position from which the drillings for analysis are selected, and in such a case there may be an argument between the steel maker and the purchaser as to the true figures which represent the percentage in the steel.

Segregation is probably one of the most common causes of the elusive trouble which is experienced by all engineers at one time or another. The trouble referred to is known as "hard spots" in steel, and it is that term which the machine man employs when he finds some portions of his steel machine normally when other portions appear very hard. It might be thought that, provided only a superficial cut can be taken over the steel, then the internal segregated zone will not affect the machinability. This, however, may not be so, for when segregated steel is forged or stamped the center portion is liable to become severely distorted so that on machining first one unsegregated part is encountered, and then adjacent to it is a harder segregated portion. For example, if rolled round or square steel bar be sulphur printed it will probably be found that if it is segregated the high-sulphur zone will be of a shape roughly similar to that of the section of the bar. If, after rounding up a square bar by forging and swaging another sulphur print be taken, it is likely that the center portion will have assumed an entirely different shape.

A common shape is that roughly described as a four-pointed star, and if such a round bar be machined there is almost certain to be machining troubles, for the tool will tend to cut the softer portions and ride over the harder, and the probability is that hard spots in the steel will be blamed as the cause. It is to be noted that the sulphur in itself is not the cause of the hardness, but it is known that when there is segregation of manganese sulphide it is likely that there will also be segregation of the carbon compounds. In consequence, when the two main hardening elements in steel, carbon and manganese, are present in greater preponderance in some parts of the steel than in others, the variation in machining qualities is easily explained.

Drilling is another machining operation which is likely to be greatly affected when segregated steel is encountered. Especially is this so when long, thin holes are to be drilled, the natural consequence being that the drill cuts the softer portions of the steel more easily, and when it runs into or alongside a harder portion the thin drill is forced out of its course, and it becomes impossible to drill a perfectly straight hole. If steel which contains a high proportion of sulphur be so drilled no trouble will be experienced provided there is no segregation, and there is no likelihood of distorted holes being produced, for all the steel will be of the same hardness and the drill will run straight.

When segregated steel comes to be case-hardened other troubles arise. Apart from the machining operations it will frequently be found that in those portions of the carburized part where segregated and unsegregated steel are adjacent, lifting, scaling, or peeling of the case will occur. It is possible that this will not happen until the part has been finished, machined, and ground, or, maybe, not until the part has been put into service and run for some time. When this arises the consequences may be serious, and in any case the cost of replacement is certain to be higher. ("Metallurgical Chemist" in *Mechanical World and Engineering Record*, vol. 85, no. 2199, Feb. 22, 1929, p. 169, *p*)

Thermodynamic Laws Applied to Perpetual Motion

THE first and second laws of thermodynamics have application to the discussion of perpetual motion. The first law of thermodynamics is an illustration of the general law of conservation of energy, according to which when work is transformed into heat or heat into work, the amount of work is always equivalent to the quantity of heat.

The second law is simply the formulation of the experimental fact that heat always flows from a body of higher temperature to one at a lower temperature. From this law is obtained the Principle of the Degradation of Energy, which may be expressed as follows: Every natural process is accompanied by a certain degradation of energy or thermodynamic degeneration. As a result of this principle the ultimate quantity of energy taken from a system as useful can never be equal to the amount given the system because of the frictional losses of transformation and transmission, energy being required to perform these processes.

All forms of energy can be transformed into heat, and, aside from very small losses, some forms are mutually convertible, mechanical and electrical energies furnishing the best example. But only a part of a given quantity of heat can be transformed into work. This brings us to the division or classification of energy upon the basis of convertibility: Energies such as mechanical and electrical, which are practically capable of complete conversion to other forms, are called high-grade energies, and energy such as heat, which is not even closely capable of complete conversion, is called low-grade energy. It is a definite tendency of nature for high-grade energy to degenerate into the low-grade

form, heat—hence the Principle of the Degradation of Energy.

Every device which either transforms or transmits energy possesses friction in one form or another. It may be in two surfaces rubbing together, or it may be in internal molecular friction such as hysteresis losses in iron due to the variation of magnetic flux within it, or the heat loss in conductors carrying current. Nevertheless friction in some amount always exists, and its value is usually calculable. It is an experimental fact that friction always produces heat, and we have become so accustomed to this phenomenon that friction connotes heat.

The author points out, therefore, that since the perpetual motion device must involve friction, it can never exist. He points out, however, that although the second law of thermodynamics says that heat cannot flow uphill, Clerk Maxwell offered a theory by which the law might be disproved. What is more, although the process indicated by him in this connection would violate the second law of thermodynamics, it has not been shown that it cannot be done. Dr. Heyl points out that the second law of thermodynamics has been placed somewhat on the basis of probability, and although a large quantity of heat might possibly flow uphill it would be highly impractical for it to do so. Hence one can understand the saying attributed to Planck that if a kettle of water be placed on the fire there is a chance, though an exceedingly small one, that the water will freeze. (B. L. Robertson, Assistant Professor of Electrical Engineering, Pennsylvania State College, in *The Penn State Engineer*, vol. 10, no. 4, Feb., 1929, pp. 13, 28 and 30, 2 figs., *g*)

MOTOR-CAR ENGINEERING

A Diesel-Engined Six-Wheel Truck

DESCRIPTION of the British Mercedes-Benz 10-ton truck, the first of its class to be placed on the British market. Though classed as a 10-ton, the machine is capable of taking much heavier loads, and a similar chassis, though having a longer frame than the British, has in Germany carried a useful load of 17 tons. It is equipped with an 80-hp. six-cylinder engine, 105 mm. (4.13 in.) bore and 165 mm. (6.49 in.) stroke, and forms a three-point supported unit with a dry disk clutch and four-speed gear box.

The spiral-bevel back axles are joined by a short, spherical-headed torque member enclosing the intermediate driving shaft, while the live-axle shafts are carried outside the axle casings and drive the wheels through spur gearing. Suspension is by inverted semi-elliptic springs centrally pivoted on the outer ends of a cross-member carried under the arched-frame side members. The latter are 11 in. deep and have flanges 5 in. wide where the greatest strength is required, and are unswept over the front axle. At the rear they are straight and parallel when viewed in plan, but in front converge to a narrower width. All the road wheels are of the G. F. Simplex pattern, equipped with 42 × 9-in. Dunlop pneumatic tires. A feature of interest is the grouping of the grease-gun connections on the back axles to facilitate the lubrication of the brake mechanism and other moving parts of the bogie.

The chassis has a wheel base of 20 ft. 9 in. measured from the center of the front axles to the midway point between the back wheels, which are 4 ft. 2 in. apart; the overall length is 32 ft. These, however, are not the only dimensions of chassis made. (*The Motor Transport*, vol. 48, no. 1248, Feb. 11, 1929, p. 162, 2 figs., *d*)

The Deguingand Two-Stroke-Cycle Motor

THIS motor has four cylinders but only two combustion chambers. Cylinders 1 and 2 constitute a pair, with pistons moving up and down together, and cylinders 3 and 4 also constitute a pair. The explosions take place within the space above the two pistons constituting a pair, but the exhaust escapes through ports uncovered by the piston in only one of the cylinders, the corresponding one admitting the fresh charge. In this way no piston deflector is required, for it is the space between the two cylinders which prevents the fresh gases from mixing with the exhaust gases.

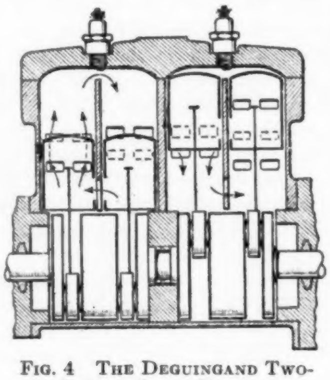

Fig. 4 The Deguingand Two-Stroke-Cycle Engine

Cylinders 2 and 3 are connected to the carburetor, and it is on the upstroke of the pistons that the mixture is drawn in and then passed into cylinders 1 and 4. The crankshaft has a roller bearing at the center and ball bearings at each extremity; the connecting-rod big ends have roller bearings. It is stated that this engine, which has a bore and stroke of 60 mm. × 65 mm., develops 15 hp. at 3000 r.p.m. (*The Autocar*, vol. 62, no. 1735, Feb., 1927, p. 206, *d*)

POWER-PLANT ENGINEERING (See also Measuring Apparatus: An Electrical CO_2 Meter and Aspirator)

The Fineness of Pulverized Coal

THE author questions whether the demand for high percentages to go through 200 mesh is justified. Grinding finer than necessary is expensive. The author claims that more and more engineers are coming to the conclusion that if all the coal passes a 50-mesh standard screen it will fulfill all the requirements. In such a case the quantity of superfines, i.e., material passing 200 mesh, is let be what it may.

Grinding so that all will pass 50 mesh, a yield of 80 per cent through 200 mesh will be obtained with some exceedingly friable coals, such as New River, especially when dry or when heated air is drawn through the mill, whereas, as low as 30 per cent will be obtained with sub-bituminous coal, particularly if high in moisture. Control of the maximum permissible size can readily be made a mechanical function of any method of grinding. The yield of superfines reverts back to the nature and condition of the coal that can be equalized only by a tremendous variation in the cost of pulverization.

It is claimed that a large percentage of superfines has a certain value regardless of the greater cost of pulverization, and that a high percentage of superfines require less furnace volume and can be completely oxidized with less excess air, regardless of the fact that there will be a percentage in any milling system just passing the 50 mesh, or perhaps even coarser, that must have time, distance to travel, and space to burn.

Unfortunately, there have been no generally acceptable tests made as to the effect of varying percentages of superfines on combustion. It would be necessary to make such tests with a wide range of coals, covering a wide range of furnace conditions both as to design, ratings, and methods of firing, before any definite conclusion could be made. The coal would all have to pass a given mesh, say, 50 mesh, at one end of the scale and be fired with definite proportions of 200 mesh, say 30, 50, 70, 80, and 90 per cent. Until such tests are made, the value of superfines can only be conjectural. There are so many factors that enter into the efficiency of a given installation that have nothing to do with fineness, that to determine the value of superfines it is necessary to

make it the only variable in a given test to get a basis for definite conclusions.

After several years' observation of a great variety of furnaces, kinds and character of coals, and methods of firing, the author's conclusion is that a high percentage of superfines adds nothing to the efficiency of combustion, the rate of combustion, or any other feature of burning pulverized coal that may have merits in its favor.

The author claims that there may be agglomeration of the finest particles in the coal into flakes that may greatly exceed in size the largest individual particles coming from the mill.

It is hard to account for the large quantity of flake-like ash particles encountered in the flue gases, particularly when the coal is fed in a dense stream with little primary air, except that they are the skeletons of large agglomerations of coal particles. The ash from the original finely divided coal particles, individually oxidized, would have been colloidal in size. Not infrequently, under furnace conditions where the coal is only partially burned, coke particles may be captured in the passes of the boiler that greatly exceed in both bulk and weight the largest individual particles coming from the mill.

It is highly probable that the best combustion with any product or high volatile lies in the range from 50 to 200 mesh, with little or none finer than 200 mesh. Going from 100 mesh to 200 mesh increases the number of particles eight times, but only increases the surface area by two. Is it not possible that the increased density of the dust cloud, containing eight times as many particles, may retard the heating up of the entering coal and air mixture by obstructing radiant-heat penetration that would more than offset merely doubling the area? If the tendency of the larger particles to stay in their own atmosphere of air is enormously greater, there is less tendency to agglomerate. (H. G. Lykken, Strong-Scott Mfg. Co., in *Power Plant Engineering*, vol. 33, no. 5, March 1, 1929, pp. 312–313, *p*)

Turbine Blade Lashing

AT THE South Philadelphia Works of the Westinghouse Electric and Manufacturing Company there has been installed a crankshaft blade-testing machine. It consists of a casing and two cylinders supported on the same frame with the motor. The casing contains a two-throw crankshaft fitted with connecting rods which drive pistons guided in cylinders. At the heads of the pistons are bolted hollow piston rods. The blades to be tested are assembled in the usual way in four special blocks which are then securely bolted to the hollow piston rod. The crankshaft is driven by a variable-speed motor through a flexible coupling and may be operated at any speed between 400 and 1800 r.p.m.

When the machine is operated, as a result of the reciprocating motion of the blade block with the definite frequency, say, of 30 cycles per sec., an alternating force of the same frequency is created, which, by its action on the blades, sets up the same type of vibrating under service conditions.

Tests were carried out to determine lashing design, with the result that the life limit of vibrating blade segments was increased six to eight times.

It was also found that when the lashing wire is made too heavy in comparison with the blade segment, the endurance limit of the overstressed blades is reached before the lashing wire approaches the point of failure. The best lashing, therefore, is one of such type that the distribution and absorption of stresses by the blades and the lashing will be accomplished in such a way that the point of failure of the blades and lashings will be reached at about the same time. In other words, the resistance capacity of the material in the blade and in the lashing will be utilized to the fullest extent. (B. Anoschenko, Turbine Engineering Department, South Philadelphia Works, Westinghouse Elec. & Mfg. Co., in *The Electric Journal*, vol. 26, no. 2, Feb., 1929, pp. 86–87, 3 figs. *de*)

Developments in the Atmos Boiler

THE Atmos boiler (described in MECHANICAL ENGINEERING, vol. 45, no. 4, April, 1923, p. 253) was developed in Sweden. Its characteristic feature is that it is of the rotating type, a water film being maintained against the drum by centrifugal force. As originally designed, the unit, for example, at the Fors Cellulose Works in Sweden has four rotors each of 305 mm. (12 in.) external diameter, 17 mm. (0.66 in.) wall thickness, and 3.4 m. (10.15 ft.) effective length in the furnace chamber. This boiler operated continuously at about 5000 kg. (11,000 lb.) per hr., 100 atmos. (1422 lb.) gage pressure, and 450 deg. cent. (842 deg. fahr.). The rotors are seamless pressed or drawn tubes of open-hearth manganese steel (0.92 manganese). The material was found to retain good mechanical properties at high temperatures, as shown in a table in the original article. The boiler is equipped with a superheater and economizer. At first chemically purified water was used, but the purifying process did not prove to be reliable. An evaporator was therefore installed and all trouble from this source was eliminated. Interesting improvements in this boiler were made by the Alsatian Society of Mechanical Constructions, French licensee under the Atmos patents. This company installed for experimental purposes a boiler which was first built with two rotors differing from those of the original construction in that they have balanced stuffing boxes to take up the actual thrusts. The speed of the rotors is 330 r.p.m., this relatively high speed being required first to maintain the annular layer of water in the rotors, and, second, to obtain sufficiently large forces for the feedwater regulator. The author, however, sought to reduce the speed of revolution of the rotors, and, with this end in view, recommended a departure from the principle of the annular layer by operation at such low speeds that the water level in the rotors would be horizontal, the control of the feedwater being then regulated by the height of the water in the rotors. Tests carried out at Mülhausen in August last, at pressures of from 100 to 110 atmos., proved entirely satisfactory. The speed of the rotors was reduced to 20 r.p.m., the power required to drive them being thus decreased from $1^1/_2$ hp. to about 0.2 to 0.3 hp. per rotor. The evaporative power of each rotor being reduced at the same time, it becomes necessary to use a number of rotors in parallel in order to attain high outputs. The favorable results obtained led to further simplifications in construction, making possible unit rotor outputs up to about 25,000 kg. per hr. This is achieved by providing the ordinary rotor with an outer ring or "cage" of straight tubes of about 100 mm. internal diameter in which the principal evaporation occurs. Forced feedwater supply is given to each tube, and the steam produced flows from the peripheral tubes through radial connecting pipes to the main central tube of the rotor, and thence to the superheater. The connecting pipes originate from the center of the peripheral tubes, so that the latter are always only half-full of water.

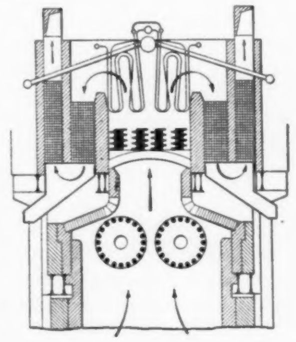

FIG. 5 ATMOS BOILER WITH TWO SQUIRREL-CAGE ROTORS

A rotor built on this principle, and tested in the experimental boiler, consists of one of the earlier rotors as central tube, surrounded by twelve straight tubes of 80 × 102 mm. (3.14 × 4.01

in.) diameter, lying on a circle of 660 mm. (25.9 in.) diameter. With this equipment running at 13 r.p.m. an evaporation of 4000 kg. per hr. was obtained, the inlet temperature of the water being 270 deg. cent.

The construction of the rotor is such that the central and peripheral tubes, and the latter among themselves, can expand and contract quite freely. The outer "cage" of tubes has an expansion indicator, and so has the central tube, hence the wall temperatures can be read at any time. Covers on the free ends of the peripheral tubes permit them to be inspected and cleaned easily. Owing to the comparatively thin walls of the outer tubes, they are subject to much lower thermal stresses than the rotors, hence the peripheral tubes might be made of ordinary material, but it is recommended that they be of the special high-grade steel already mentioned. The relatively large diameter of the evaporating tubes facilitates periscopic inspection before erection, and the elasticity of the construction eliminates uncontrollable thermal stresses.

The new type of Atmos boiler has a further advantage in that it can be operated with feedwater purified by ordinary means, i.e., without distillation. Sludge separating from such water is precipitated mainly in the collector between the rotor and the economizer, where the water is raised to the boiling point. Scale deposited in the boiler is naturally in the form of a uniform layer in the evaporating tubes. The thicker this deposit becomes the greater the thermal resistance and the higher the temperature of the tubes themselves, but this temperature is measured by the expansion indicator, which shows with certainty when the boiler needs cleaning. Any sludge carried in by the feedwater simply involves cleaning the tubes sooner than would otherwise be necessary. Furthermore, a certain fraction of the feedwater can be blown down after it has passed through the evaporating tubes, thus keeping down the concentration of the boiler water. The overflow water can also be used to regulate the feedwater supply, thus maintaining any desired forces in the feedwater regulator.

Two of the new "squirrel-cage" rotors are being fitted in a boiler for the Elsässiche Mascheninfabrik to supply 10,000 to 12,000 kg. of steam per hr. at 100 atmos. gage pressure. The construction of this boiler was actually completed, with the exception of the rotors, before it was decided to use two of the new rotors instead of eight of the original design, as first intended. There is no difficulty in building a single squirrel-cage rotor for 12,000 kg. per hr., but the available space in the boiler mentioned does not permit the installation of such a unit. Fig. 5 shows the boiler in section.

The steam raised in this boiler will be expanded in a 700-kw. Zoelly turbine, built by the Société Alsacienne de Constructions Mecaniques, from 80 atmos. (gage) and 400 deg. cent. to from 12 to 15 atmos., at which pressure it will be passed into the header of the existing boiler, and will flow thence to one of the two existing condensing turbines for final expansion. The existing boiler will be shut down. (J. V. Blomquist in *Engineering and Boiler House Review*, vol. 42, no. 8, Feb., 1929, pp. 397–399, 6 figs., *d.* Reference in the paper is made to a paper by Loutz, Chief Engineer of the Alsatian Society of Mechanical Constructions, presented at the International Congress on Industrial Heating in Paris.)

REFRIGERATION

A Machine for Making Ice Flakes

LONG ago, refrigerating engineers, notably Holden, experimented with the idea of freezing ice by revolving a refrigerated drum in a tank of water. The ice was removed by a set of knives, but the disadvantages offset the decrease in room space. The knives exerted so much pressure against the drum that the power demand was high. The upkeep was also excessive, and the ice left the drum in a mushy condition. Attempts were made to squeeze out the water, but the product remained a poor substitute for can ice.

The problem was taken up a few years ago by the Flakice Corporation, and its president, Crosby Field, (Mem. A.S.M.E.) made an extensive study of continuous freezing methods that might insure a better product. From this research work has come the present Flakice machine.

The principle of this apparatus is the freezing of a thin layer of ice upon a metal surface and the removal of this ice in flakes by mechanically distorting the metal. The principle can be incorporated in machines using any of several types of freezing surfaces, such as a cylinder or a disk.

The machine, Fig. 6, makes use of a drum partly submerged in the water to be frozen and inclosed in an insulated box. This drum is made up of a series of Mond 70 metal cylinders attached together to make a continuous drum by special rubber ligaments.

A hollow shaft, driven through a gear box by a motor, carries the drum. Brine enters the hollow shaft by the pipe *B* and issuing out of a set of nozzles, impinges on the inner wall of the drum.

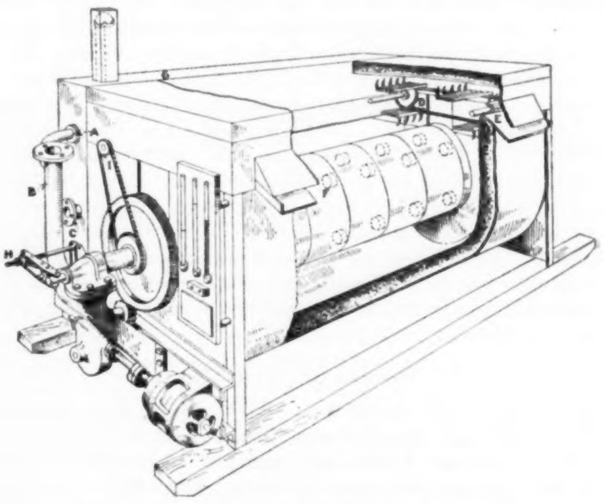

FIG. 6 THE FLAKICE MACHINE

It flows back through the other end of the shaft into the surge tank *G* and out through the connection *C* to the brine cooler, which is a separate apparatus. Excessive brine pressure is avoided by the connection *A* between the outlet and the overflow pipe.

Inside the drum is a set of rollers *F* attached to a shaft passing through the hollow shaft. The operation is as follows: The brine is pumped through the shell, which is revolved by the gear. The chilling of the cylinder causes the water touching the metal to form into a thin sheet of ice, and when this ice is of sufficient thickness the lever *H* is shifted to bring the rollers *F* against the drum shell. The latter is deformed by the pressure of the rollers; the ice then breaks loose, as at *B*, Fig. 7, and is gathered by the rod rollers *D*, which are drawn by the gear *I*. The conveyor rollers move the ice to the exit *E*. This ice is not mushy but can be termed "dry." The rollers are then withdrawn, and the freezing process is continued.

If the rollers be maintained at their maximum deflection continuously, then there appears a new phenomenon, called "freezing under." To understand this phenomenon it must be borne in mind that the thicker the ice cake the less the amount of deflection required to clean it off. As the ice first forms on the cleaned metal surface, it is quite elastic and will follow the contour of the

curved surface under deflection without cracking or showing any signs of peeling. As it grows, however, it reaches a thickness which, although not enough to cause it to peel, is enough to maintain its original form and not follow the metal as it changes its shape while passing over a roller A. The result is a hollow space, as at B, C, and D, Fig. 8, between the under surface of the ice and the metal, which extends for a short distance on either side of the point of tangency of the roller with the metal heat-transfer surface. Into this space water rushes and is quickly frozen to both the under surface of the ice cake and the cylinder. The ice cake thus formed is built of numerous laminations, all frozen together, but which, when broken, clearly show the marks of each individual layer. This building up continues until a total thickness is reached, when the ice peels, as at E and rises to the top in the

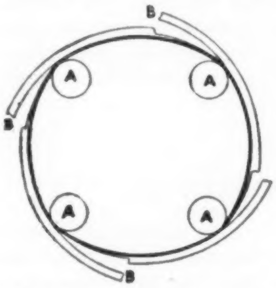

FIG. 7 BREAKING OFF THE FLAKES WITH INTERMITTENT FREEZING

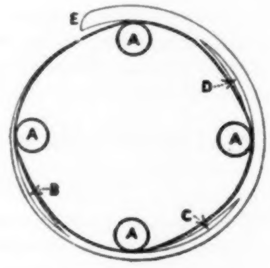

FIG. 8 ACTION WHEN THE SHELL IS CONTINUOUSLY DISTORTED

same manner as by the "intermittent deflection" or "freezing-under" conditions.

Clear ice can also be produced. In this case the rollers are maintained in the position of maximum deflection, but the cylinder is stationary during the freezing period and is caused to peel its ice by rotating for a short period at intervals.

The original article is based on an interview with Crosby Field and on a paper presented by him before the American Society of Refrigerating Engineers. (*Power*, vol. 69, no. 12, March 19, 1929, pp. 474–475, *dA*)

SPECIAL PROCESSES

The Einstein Process of Metallizing Non-Conducting Materials

THE Einstein process has for its basis a preparation which, when applied to the surface of any material, renders that surface electrically conductive so that metals can be deposited on it as in ordinary electroplating. The merits claimed for the invention lie, it seems, in the fact that the Einstein preparation penetrates further into the material than has hitherto been possible; and as the metal deposit follows the preparation, the metallic coating also penetrates deep into the material.

It is claimed that by this process non-metallic materials can be coated with almost any metal. Samples of three-ply wood were exhibited in London with deposits of zinc, brass, copper, aluminum, silver, and gold. The coating was fairly thick, in most cases 0.25 mm. (say, 0.01 in.), but the grain of the wood was still repeated on the surface. (*Flight*, vol. 21, no. 2/1046, Jan. 10, 1929, p. 25, *g*)

THERMODYNAMICS

Extension of the Callendar Steam Tables and Equations by Direct Experiment to 4000 Lb. per Sq. In. and 800 Deg. Fahr.

THE most important result of the present investigation has been one showing that the simple form of adiabatic equation

$$P/T^{13/3} = \text{constant} \qquad [1]$$

holds with such remarkable accuracy in the critical region that it is not necessary to make any change in the value of the index 13/3, which has already been adopted so widely in many countries. It was feared at first, on account of the universal acceptance of the van der Waals theory of the critical state for more than fifty years that Equation [1], though it might afford a useful approximation at moderate pressures, where it had already been verified, could not possibly be accurate near the critical point, but would require the index to increase to nearly twice its value, as would in fact be the case if the orthodox theory were correct. It had not previously been possible to make any adequate experimental test of this theory, since such a test required very accurate measurements of the total heats and densities of both liquid and vapor in the critical region. Even in the case of CO_2 (with a critical pressure of only 73 atmos. at a temperature of 31 deg. cent., which is convenient for accurate observation and regulation), the latent heat had not been measured successfully at a temperature higher than 20 deg. cent. The difficulties were greatly enhanced in the case of steam by the high critical pressure and temperature, namely, 218 atmos. and 374 deg. cent. These difficulties have been surmounted satisfactorily for the first time, though not without great pains and labor and continuous application to the problem in all its aspects for more than thirty years. The experimental results are found to be quite inconsistent with the van der Waals theory of the critical state, but in perfect agreement with the fundamental assumption made in the original paper on the basis adiabatic Equation [1], namely, that "The internal energy E of the vapor is proportional to the product $P(V - b)$ at all stages of coaggregation and not only in the limit at zero pressure." Expressed in terms of the total heat $H = E + aPV$, this condition has been used in Callendar's "Steam Tables" for years in the general form

$$H - B = (13/3)\, aP(V - b) + abP \qquad [2]$$

in which B and b are constants to allow for the zeros from which H and V are reckoned, and a is the factor for reducing PV to heat units.

The importance of Equation [2] as affecting the adiabatic Equation [1] is that the latter cannot easily be verified directly at high pressures by the method originally employed of measuring the temperature in expansion or compression with a compensated platinum thermometer, whereas Equation [2] can be verified without serious difficulty by measuring H and V. It suffices, therefore, to show that [1] is a necessary consequence of [2] and follows directly from it by the law of thermodynamics. A proof of this is given in Professor Callendar's book, "Properties of Steam," p. 53.

A series of experiments have been carried out on the saturation volumes by using Professor Shenstone's fused-quartz tubes. The expansion of liquid could be observed up to 374 deg. cent. accurately, and beyond that with rapidly diminishing accuracy.

The specific volumes actually observed at 374 deg. with fresh tubes were 3.79 cu. cm. per gram for the vapor, and 2.28 cu. cm. per gram for the liquid, being very nearly in the ratio of 5 to 3. This was evidently quite inconsistent with the orthodox theory of the critical state, according to which the densities should become equal at the point where the meniscus vanished, and the saturation lines, representing the densities of the liquid and vapor, should meet each other in opposite directions with the critical isothermal as a common tangent.

On the other hand, the experimental curve for the density of the vapor could be represented accurately by an equation (a modified form of the Joule-Thomson equation) given in the original article, and expressing V in part as a function of c (reduction

of volume attributed to the formation of multiple or complex molecules by coaggregation).

The equation thus modified would also put the saturation pressures within the somewhat elastic limits of error set up by the observations available. The author adds, however, that at the same time it would have been very risky to put forward such a heterodox equation without making sure that it would also fit the total and latent heats and would give a reasonable correlation of all the required properties of all the liquid and vapor.

The author has also extrapolated a previously known equation for the expression of the total heat of the water to the critical point, and in this way obtained a curve which he calls the "thermodynamic-equation curve." He claims that it was found that his equation fitted much better with the van der Waals equation and gave far more satisfactory values of H (total heat) and L (latent heat) than Maxwell's theorem (certain of the conditions

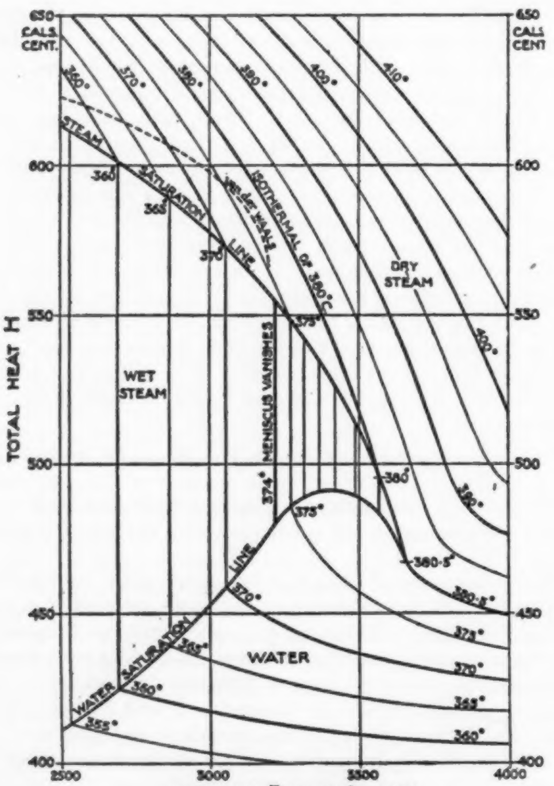

FIG. 9 *H-P* DIAGRAM FOR STEAM

on which this equation is based, however, do not appear to agree with the actual measurements).

One of the most interesting parts is the *H-P* diagram for steam (Fig. 9) This diagram represents actual observations from which it was in the first instance directly plotted. The saturation temperatures were found to be in close agreement with those of Holborn and Baumann, but the latent heat did not vanish at 374 deg., where it had the value 72.4 pound calories, equal to 130.3 B.t.u. per lb. The saturation lines for both liquid and vapor could be traced up to 380.5 deg. cent., where they appeared to meet in a sharp cusp tangential to the isothermal, at a pressure of 3650 lb. Beyond this point the isothermal of 380.5 deg. made an abrupt bend, and became parallel to the lower isothermals of water, showing presumably that all the molecules of steam were condensed.

The conclusion to which the author comes is that all the phenomena of the critical state can be simply represented by the coaggregation theory. Similar phenomena have been observed with many other liquids when heated in quartz tubes, but the difficulties of purification in sufficient quantity prohibit the employment of other methods. In the case of steam the results have been verified in the critical region by three independent methods, which all give consistent results, namely (1) the measurement of H and h, (2) that of V and v, (3) and the calculation of the saturation pressures. These agree with the results of the throttling method, and with the direct verification of the adiabatic at lower pressures. Such evidence has a high cumulative value, and it seems fair to conclude that the equations by which the results are represented are sufficiently accurate for most practical purposes over the whole experimental range, though they may yet be improved by further research. (Prof. H. L. Callendar, F.R.S., in Report Ref. J-T 43, received from the British Electrical and Allied Industries Research Association; abstracted through *World Power*, vol. 11, no. 61, Jan., 1929, pp. 11–16, 4 figs., *etA*)

TRANSPORTATION

Heavier Loading of Freight Cars

THIS subject is of considerable interest to railroads because the efficiency of utilization of rolling stock depends upon the degree of loading of freight cars. There has been, however, a consistent effort on the part of railroads to persuade and to some extent compel shippers to load cars as fully as possible. A part of this program has been the institution of minima, or amounts which must be loaded per car in order to obtain carload rates. The subject came up for discussion at the January meeting of the Atlantic States Shippers' Advisory Board, in which it was brought out that the matter is somewhat involved and is affected in part by the trade customs and conditions and also by the fear of shippers that heavier loading will mean higher minima. The following information affecting certain goods may be of interest as it shows among other things that at least in certain classes of goods heavier loading is possible. The following data are taken from remarks by W. C. Kendall of the American Railway Association:

Anthracite. 967,007 cars loaded in 9 months, with the average loading varying from 44.8 to 54.1 tons per car. Increases, compared with 1926, were recorded on four roads and losses on five. Would any one say these losses were due to a decrease in the car capacity? There has been no decrease in capacity of coal-carrying cars.

Bituminous. 1,057,595 cars loaded in 9 months, with tonnage varying from 50 to 75 tons per car. Increases on five roads, losses on two. Obviously, there has been no decrease in average car capacity.

Coke. 118,275 cars loaded with tons per car varying from 22.7 to 37.6; six roads record an improvement, one of 4.6 tons, while two record losses. Does it seem likely that regular receivers of coke, generally, are limiting shippers to less than 22.7 tons per car?

Mention has been made of these commodities principally because they load in quantity on the roads serving this territory, and all are susceptible, generally speaking, to a full carload. They are of high density and there can be no question about the practicability of getting full-carload tonnage in each car.

When this subject has been presented heretofore, much has been said about trade units, requirements of the consumer, or ability of receiver to handle at destination, all of which were presented as affecting the possibility of the shipper's giving the car a full load.

Mr. Metzman of the New York Central Railroad spoke of the

attitude of shippers, particularly the matter of fear on the part of some of them that the railroads will be arbitrary in their action by increasing the carrying capacity of equipment. They fear that if the railroads continue to increase that capacity—e.g., from a 40-ton box car to a 55-ton one (and he had just recently been told that in Canada they were building a 60-ton box car and didn't know how much farther they were going)—the minima will also be increased in comparison with the capacity of the car.

There is this angle to the increase in the capacity of the box car: It is generally known that we cannot always obtain the maximum load in a box car, but whenever we do and whenever we are able to get a 55-ton box-car load, the increase in that carload is just that much more revenue per unit to the railroad company. So far as using that as an arbitrary basis for increasing the minima, there need be no fear of that.

The shippers' side was in part presented by C. R. MacCarey, of the Hercules Cement Co., Philadelphia, Pa., chairman of the Cement Committee of the Association, who stated that in their industry they have units that have been established, based on the 60,000-, 80,000-, and 100,000-lb. capacity cars, and when a man orders a carload of cement on a small order—a minimum carload—he has firmly fixed in his mind how many barrels he is going to get. He may have a particular job where he will use 173 barrels of cement. If a car is sent him with axle loading he may have to truck or sell or dispose of considerable cement that he cannot use on that particular job. The advisability of raising their trade units for the different-sized cars, the speaker said, would have to be taken up with their committee through the sales department. He inquired whether axle loading was always uniform on a given-size car, and whether carriers knew anything about that, to which Mr. Kendall replied it was not.

Having established these trade units, the speaker said their industry would be in rather an awkward position if they gave a man 173 barrels in one car, 198 in another, and 205 in a third, for he would not know how much cement he was going to get, and could not make his calculations for using it. If there was any way that the carriers could arrive at a specific weight, axle loading, or maximum loading, on cars of 60,000, 80,000, and 100,000 lb. capacity, it would help a great deal in establishing the minima desired. If information could be obtained, progress along that line could be made.

As a shipper the Association would like to have the minima raised as high as possible, because then the customer would have to buy more cement, but as a receiver of freight, that was another matter. The shippers have to lay out money and naturally want to buy as little as possible, because it is a good operating service that the carriers are giving now; but if the purchasing department of the Association asked to look into the matter, something might be done along that line.

The Association has put in service twenty bulk cement cars with an axle loading of 163,700 lb. and operates those cars with every pound they will carry, approximately 435 barrels of cement. They can only send these to certain consignees who are in a position to use all the cement at one time. Now the average carload of cement is 200 barrels. Two average carloads of cement are moved in these cars, but that should not be the minimum, because most consignees cannot handle it. A man may have his storage facilities arranged for a certain amount of cement and will not build a big warehouse to handle 500 barrels of cement if he can build one that will house 173, which is found to be the preponderant car size. Apparently 50 per cent of the cars are 60,000-lb. capacity cars. If heavier cars are used in the cement industry in the summer, better loading will result. (*Proceedings of the Fifth Annual Meeting of the Atlantic States Shippers' Advisory Board*, New York, Jan. 18, 1929, pp. 13–16, *g*)

VARIA

The Dill Bill on Forfeiture of Patent Rights

THE Dill bill, on which no action was taken by the Senate in the Seventieth Congress, is known as S. 2783 and provides for the forfeiture of patent rights for violation of the anti-trust laws. In its original form it was introduced in the Senate on Jan. 23, 1928, by Senator Dill of Washington, and provides that forfeiture of patent rights is to follow automatically in the event of conviction of violation of the anti-trust laws. This drastic provision was later rewritten to the effect that "It shall be a complete defense to any suit for infringement of a patent to prove that the complainant in such a suit is a party to any illegal combination." From the hearings which were held by the Committee on Patents of the Senate it would appear that the bill was provoked by the situation in the radio industry, where two or three companies have such extensive patent holdings as to give them an alleged monopolistic influence on business in their respective fields. The Commissioner of Patents was the principal defender of the patent system in the hearings and declared that the proposed bill would undermine the entire patent structure upon which American industry is reared. The existing situation was also vigorously defended by the Judge Advocate of the U. S. Army. The following quotation from the statement by the Commissioner of Patents is cited:

"The point which seems to impress me most about this bill is that if any patent owner, and I mean licensee as well, is engaged in anything which thereafter is held to be in restraint of trade, even though at the time it is started the courts are holding that it is not in restraint of trade, under the provisions of this bill the court must say: 'No, you cannot have any relief in a court of equity under your patent rights.'

"I think that is a grave danger to the patent system, and being a grave danger to the patent system, is a grave danger to the industries of this country founded upon patents."

Commissioner Robertson referred to a case involving restraint of trade in which the Supreme Court reversed itself, and added:

"If any practice like that is indulged in after the Dill Act of 1928 passes, why the owner of that patent in following out what the Supreme Court might say is not in restraint of trade, but which it afterward says is in restraint of trade, would be robbed of any right of coming into a court of equity."

A bulletin issued by the National Machine Tool Builders' Association, over the signature of its general manager, Ernest F. DuBrul, states:

"An innocent licensee may have built up an entire business under the protection of a patent license. But under this bill he could be deprived of the protection of the patent, and would be compelled to meet open competition by infringers.

"It would be impossible to tell in advance just what patents might be affected by a conviction for violation of the anti-trust law. No provision is made for identifying such patents. Therefore, before taking a license the proposed licensee would have to make a search as to violation of the anti-trust laws, not only by parties with whom they are negotiating a license, but by any and all assignors and licensees and any other party having any interest at all in the patents during their life." (*Iron Trade Review*, vol. 84, no. 13, Mar. 28, 1929, pp. 839–841, *g*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society

A.S.M.E. Research on the Physical Properties of Steam

AT THE suggestion of the Executive Committee for the Steam Table Fund, Messrs. G. A. Orrok, D. S. Jacobus and A. M. Greene, Jr., an enlarged special research committee of the Society has been appointed by President Sperry. This committee, headed by Past-President Dow as its chairman, will from now on be in executive charge of this research project on the properties of steam and the extension of the steam tables.

It will be recalled that the present investigation of this important subject grew out of an informal conference of experts in this field which was held at Harvard University, Cambridge, Mass., on June 23, 1921. At the close of this conference a five-point program of research was recommended to the A.S.M.E. Research Committee and to the various interests concerned with the generation and use of steam, and favorable consideration was urged. The proposal was accepted by the Committee in the name of the Society and the latter made the necessary arrangements to receive and disburse the funds collected by the Executive Committee named above.

The following is the program in the form framed at the Cambridge conference:

1 The experimental determination of the specific heat of water with the greatest possible accuracy up to its boiling point at atmospheric pressure to make possible a more accurate determination of the mechanical equivalent of the mean heat unit. The determination of the specific heat of water at higher temperatures for the better determination of the heat of the liquid.

2 The experimental determination of the pressure-temperature-volume relation of superheated steam at high pressures and over as wide a range of superheats as possible.

3 The experimental redetermination of the density of liquid water over a wide temperature range above that at which satisfactory data are now available.

4 The experimental determination of the Joule-Thomson cooling effect in superheated steam at pressures up to 600 lb. and at temperatures up to 600 deg. fahr.

5 Independent measurements of the specific heat at constant pressure of superheated steam at higher pressures than those covered by the Munich experiments as a check on the volume and Joule-Thomson measurements.

In due time work on Part 1 was begun at Harvard University under Dr. H. N. Davis, Part 2 was undertaken by Dr. F. G. Keyes at Massachusetts Institute of Technology, and Drs. N. S. Osborne and H. F. Stimson began the construction of their calorimeter for the total- and latent-heat measurements at the Bureau of Standards.

Beginning with December, 1922, all three of these laboratories made annual reports at a special Steam Table Session of the A.S.M.E. Annual Meeting. These reports will be found in the next following February issue of Mechanical Engineering. Reprints of these reports were broadly distributed to the contributors to the Fund and others specially interested in this research. A considerable number were sent to experts on steam residing in Europe. This led to a cordial interchange of data and experiences between the American Committee, and the workers in Great Britain, Germany, Switzerland, and Czechoslovakia.

At international meetings and conferences of the World Power Conference and other technical bodies interested in this subject the progress of this research in the United States and the European countries has been noted with interest. Each time the desirability of ultimately developing a steam table which would have universal acceptance has been stressed. This point of view was shared also by those who attended the meeting of I.E.C. Advisory Committee No. 5 on Steam Turbines at The Hague, May, 1928, and the technical sessions of the Centenary Celebration of the Institution of Civil Engineers, London, June 1928.

Correspondence has passed recently between the investigators and their supporting organizations in Great Britain, Germany, and the United States relative to a proposed international conference of the experts at present at work on the properties of steam. The British Committee has invited these workers in all countries to confer in London next July. This invitation, accordingly, will be one of the subjects to be considered at the first meeting of the reorganized committee.

Personnel of New Committee

Dow, Alex, *Chairman*, President, The Detroit Edison Company, 2000 Second Avenue, Detroit, Mich.

Abbott, William L., *Vice-Chairman*, Chief Operating Engineer, Commonwealth Edison Company, 72 West Adams Street, Chicago, Ill.

Bourne, George L., President, Superheater Company, 17 East 42nd Street, New York, N. Y.

Davis, Dr. Harvey N., President, Stevens Institute of Technology, Hoboken, N. J.

Dickinson, Dr. Hobart C., Chief, Heat and Power Division, Bureau of Standards, Washington, D. C.

Dollin, Frank, Engineer, Service Department, Westinghouse, Electric & Manufacturing Co., Lester, Pa.

Goodenough, George A., Professor, Thermodynamics, University of Illinois, Urbana, Ill.

Greene, Dr. Arthur M., Jr., Dean, School of Engineering, Princeton University, Princeton, N. J.

Heck, Robert C. H., Professor, Mechanical Engineering, Rutgers College, New Brunswick, N. J.

Jacobus, Dr. David S., Advisory Engineer, Babcock and Wilcox Company, 85 Liberty Street, New York, N. Y.

Keyes, Frederick G., Professor, Research Laboratory of Physical Chemistry, Massachusetts Institute of Technology, Cambridge, Mass.

Marks, Lionel S., Professor, Mechanical Engineering, Harvard University, 215 Pierce Hall, Cambridge, Mass.

Orrok, Geo. A., Consulting Engineer, Room 1208, 52 Vanderbilt Avenue, New York, N. Y.

Pigott, Reginald J. S., Consulting Mechanical Engineer, Stevens and Wood, Inc., 20 Pine Street, New York, N. Y.

Robinson, Ernest L., Turbine Engineer, General Electric Company, Schenectady, N. Y.

Plans for Faraday Centenary

IN RESPONSE to the invitation of the Royal Institution, representatives of many scientific and technical societies met in the famous lecture theater in Albemarle Street on Feb. 5, to consider the preliminary arrangements for the celebration of the centenary of Faraday's great discovery of electromagnetic induction, which he made on Aug. 28, 1831. Sir Arthur Keith was in the chair, and reminded those present that the Royal Institution was not only the scene of Faraday's labors, but it was also for more than half a century his home. Sir William Bragg, director of the Royal Institution, said that the proposed celebrations had been in mind a long time, and in choosing the particular discovery of August, 1831, they were recalling one of Faraday's most important discoveries, on which rested a vast body of scientific and industrial development. The meeting approved the appointment of two small committees to deal with the scientific and industrial sides of the celebration, which would probably take place in the third week of September, 1931.—*Nature* (London), vol. 123, Feb. 16, 1929.

Engineering and Industrial Standardization

Power Test Codes, National and International

THE series of Power Test Codes of the Society are intended to provide standard directions for conducting and reporting performance tests of power-plant apparatus such as are most commonly undertaken in connection with tests which determine all the details of the performance, but selected parts of these codes may be used for tests of limited scope. They apply further to tests which concern the fulfilment of performance guarantees, and to acceptance tests. The codes are not intended to supply directions for general research nor for the development of equipment or of processes. It is assumed, however, that the engineer who is concerned with research will proceed as nearly as practicable in harmony with their requirements, and that in the publication of results he will employ forms of presentation which will be comparable with those of the codes.

During the six-year period, 1922-1928, inclusive, 18 of the 24 tests and supplementary codes, as well as two parts of "Instruments and Apparatus," on the program of the Committee on Power Test Codes have appeared in pamphlet form. One of the supplementary codes, "Instruments and Apparatus," when completed, will include 40 parts and chapters describing the apparatus, instruments, and methods of measurement used in the testing of prime movers and auxiliary apparatus.

The Society's activity in this field dates back to 1886 when a Committee was appointed to formulate a "Standard Method for Steam Boiler Trials." This code soon became the standard practice of the profession in this country and the basis upon which performance guarantees were drawn and settled. Test codes for prime movers soon followed. The "Standard Method of Conducting Duty Trials of Steam Pumping Engines" was published in 1891, the code for "Locomotive Tests" appeared in 1893, and the report on a "Standardized System of Testing Steam Engines" was published in 1902. A comprehensive and thorough revision and extension of the A.S.M.E. Power Test Codes was begun in 1909 and completed and published in 1915. In the fall of 1918 the Council, realizing the need for a further revision and extension of these test codes, created a Standing Committee of 25 men for this purpose. This Main Committee with its 20 associated individual committees was organized in December of that year, and now includes in its personnel 118 members of the Society and 15 non-members.

The work of the Society on power test codes has not been confined only to national standardization but has played an important part also in international standardization to the end that the buying and selling of prime movers between nations might be facilitated. Through its membership in the International Electrotechnical Commission the A.S.M.E. has been actively engaged in assisting in bringing about international agreements covering acceptance tests for hydraulic turbines and steam turbines.

The World Power Conference held in London in 1924 gave an added stimulus to the power-test-code activity of the I.E.C. Prior to that date committees in Great Britain, Switzerland, Germany, and the United States had developed codes or specifications for water turbines, steam turbines, and internal-combustion engines In 1925 the U. S. National Committee of the I.E.C. invited the Society to accept membership and to designate the A.S.M.E. Committee on Power Test Codes as the active group in this country on the testing of prime movers. This invitation was accepted, and the Society through its five representatives has since had an active part in the councils on this subject.

The Society and the Main Committee on Power Test Codes participated in the New York meeting of the I.E.C. held in April, 1926. Following the New York meeting, the U. S. National Committee of the I.E.C. was designated as the Secretariat of the International Electrotechnical Commission Advisory Committee No. 4 on Prime Movers. Accordingly, in preparation for a meeting of the Advisory Committee held at Bellagio, Lake Como, Italy, in September, 1927, the Secretariat developed a proposal which it believed would assist in unifying and accelerating the work of the Advisory Committee on Prime Movers. The proposal related to the establishment of a definite outline for international recommendations for the testing of prime movers. At that meeting and since it has been generally agreed that the international agreements which the committee was striving to establish for hydraulic and steam turbines might be divided into three separate parts for each piece of apparatus. These parts would be (1) a specification, covering

NEW AMERICAN STANDARDS

The following standards were approved by the A.S.A. during the month of March 15–April 15, 1929:

Part I, on Protection of Persons, of the Code for Protection Against Lightning. (American Standard.)

Part II, on Protection of Buildings and Miscellaneous Property, of the Code for Protection Against Lightning. (American Standard.)

Part III, on Protection of Structures Containing Inflammable Liquids and Gases from Lightning, of the Code for Protection Against Lightning. (Tentative American Standard.)

Sponsored by the American Institute of Electrical Engineers and the U. S. Bureau of Standards. Published by the U. S. Bureau of Standards.

Tool-Holder Shanks and Tool-Post Openings. (American Standard.)

Sponsored by the Society of Automotive Engineers, the National Machine Tool Builders Association, and The American Society of Mechanical Engineers. Published by the A.S.M.E.

Cast-Iron Long-Turn Sprinkler Fittings. (American Standard.)

Sponsored by the Heating and Piping Contractors National Association, the Manufacturers Standardization Society of the Valve and Fittings Industry, and The American Society of Mechanical Engineers. Published by the A.S.M.E.

information with inquiry or order; (2) a commercial code, covering acceptance tests; and (3) a complete technical code. At the Bellagio meeting the document on the testing of hydraulic turbines was completed and approved by the plenary meeting of the Commission.

The beginning of an international document on the testing of steam turbines was formulated at this meeting in Bellagio, and was further developed at a meeting held during the week of May 20, 1928, at The Hague, Holland. The British Report of the Institution of Civil Engineers on "Tabulating the Results of Heat Engine Trials," the suggestion of the German National Committee for a Code for Acceptance Tests on Steam Turbines, and the A.S.M.E. Power Test Code for Steam Turbines were used as the bases for these recommendations. The Secretariat, charged with the responsibility of revising the rules formulated at The Hague meeting, is expecting shortly to distribute copies of them to the ten countries forming I.E.C. Advisory Committee No. 5 on Steam Turbines for review prior to the next meeting of the Committee, which will be held in England during the first week in July, 1929.

Member-Bodies and Representatives of the American Standards Association

IN THE ten years since its organization in October, 1918, the organization membership of the American Standards Association, formerly known as the American Engineering Standards Committee, has increased from five (5) to thirty-three (33). Each organization upon accepting membership appoints one, two, or three official representatives on the Standards Council of the A.S.A. At the present time the Council Numbers 64. The following list of member-bodies and their representatives is revised to April 1, 1929:

American Electric Railway Association
Charles Rufus Harte (1930)
W. W. Wysor (1931)
(Alternate: G. C. Hecker)

American Gas Association
H. C. Cooper (1930)
W. J. Serrill (1931)
(Alternates: C. C. Attwood and J. D. Crevelling)

American Gear Manufacturers Association
George L. Markland, Jr. (1930)
(Alternate: S. L. Nicholson)

American Home Economics Association
Faith Williams (1931)
(Alternates: Margaret M. Justin and Alice L. Edwards)

American Institute of Architects
Samuel R. Bishop (1929)
(Alternate: S. F. Voorhees)

American Institute of Electrical Engineers
J. C. Parker (1929)
J. Franklin Meyer (1930)
Frank D. Newbury (1931)
(Alternates: Henry M. Hobart, H. S. Osborne, and L. T. Robinson)

American Institute of Mining and Metallurgical Engineers
George E. Thackray (July 1, 1929)
E. A. Holbrook (1929)
George C. Stone (1930)
(Alternates: Harlow Hardinge and Richard L. Lloyd)

American Mining Congress
James F. Callbreath (1930)
(Alternate: Warren R. Roberts)

American Railway Association—Engineering Division
W. C. Cushing (1930)
(Alternates: J. R. W. Ambrose and E. K. Post)

American Society of Civil Engineers
H. H. Quimby (1930)
(Alternate: Charles A. Meade)

American Society of Mechanical Engineers
Stanley G. Flagg, Jr. (1929)
Cloyd M. Chapman (1930)
Collins P. Bliss (1931)
(Alternates: K. H. Condit and C. B. LePage)

American Society for Testing Materials
F. M. Farmer (1929)
John A. Capp (1930)
A. A. Stevenson (1931)
(Alternates: R. E. Hess and C. L. Warwick)

Association of American Steel Manufacturers
C. F. W. Rys (1930)
(Alternate: J. O. Leech)

Cast Iron Pipe Research Association
Leonard Peckitt (1930)

Electric Light and Power Group: Association of Edison Illuminating Companies; National Electric Light Association
C. F. Hirshfeld (1929)
I. E. Moultrop (1930)
W. C. Wagner (1931)
(Alternates: H. S. Bennion and Alexander Maxwell)

Fire-Protection Group: Associated Factory Mutual Fire Insurance Companies; National Board of Fire Underwriters; National Fire Protection Association; Underwriters' Laboratories
George W. Booth (1929)
A. R. Small (1930)
C. W. Mowry (1931)
(Alternates: A. L. Brown, Dana Pierce, and H. E. Newell)

Gas Group: Compressed Gas Manufacturers' Association; International Acetylene Association
A. Cressy Morrison (1929)
H. S. Smith (1930)
(Alternates: G. O. Carter and E. C. Turner)

Laundry Owners National Association of the U. S. and Canada
W. G. Conover (1931)
(Alternate: George H. Johnson)

National Association of Mutual Casualty Companies
C. E. Pettibone (1931)
(Alternate: A. S. Johnson)

National Automatic Sprinkler Association
I. G. Hoagland (1930)
(Alternate: Henry A. Fiske)

National Electrical Manufacturers Association
S. L. Nicholson (1929)
R. W. E. Moore (1930).
L. F. Adams (1931)
(Alternates: R. H. Manson, H. D. Reed, and W. J. Canada)

National Machine Tool Builders Association
F. L. Eberhardt (Temporary)

The Panama Canal
W. A. E. Doying (1931)
(Alternate: Phil P. Greenwood)

Portland Cement Association
F. W. Kelley (1930)

Safety Group: National Bureau of Casualty and Surety Underwriters; National Safety Council
David Van Schaack (1929)
Albert W. Whitney (1930)
W. Dean Keefer (1931)
(Alternates: C. B. Auel and L. A. DeBlois)

Society of Automotive Engineers
C. B. Veal (1929)
Coker F. Clarkson (1930)
A. J. Scaife (1931)
(Alternates: R. S. Burnett, H. M. Crane, and K. L. Herrmann)

Telephone Group: Bell Telephone System, United States Independent Telephone Association
A. L. Stadermann (1929)
H. L. Huber (1930)
(Alternates: J. W. Morrison and W. M. Craft)

U. S. Department of Agriculture
Thos. H. MacDonald (Bureau of Public Roads) (1929)
D. J. Price (Bureau of Chemistry) (1930)
Earle H. Clapp (Forest Service) (1931)
(Alternates: H. S. Betts, C. W. Kitchen, E. F. Kelley, and Louise Stanley)

U. S. Department of Commerce
E. C. Crittenden (Bureau of Standards) (1929)
O. P. Hood (Bureau of Mines) (1930)
R. M. Hudson (Commercial Standards Group) (1931)
(Alternates: L. J. Briggs, N. F. Harriman, and G. S. Rice)

U. S. Department of the Interior
JOHN L. SAVAGE (Bureau of Reclamation) (1929)
NATHAN C. GROVER (Geological Survey) (1931)
(Alternates: C. A. BISSELL and W. G. HOYT)
U. S. Department of Labor
ETHELBERT STEWART (Bureau of Labor Statistics) (1931)
(Alternate: LUCIAN W. CHANEY)
U. S. Navy Department
H. E. YARNELL (Bureau of Engineering) (1929)
(Alternates: ROGER W. PAINE and V. V. WOODWARD)
J. D. BEURET (Bureau of Construction and Repair) (1930)
(Alternates: H. N. WALLIN and GEO. C. CALNAN)
WM. D. LEAHY (Bureau of Ordnance) (1931)
(Alternates: C. R. ROBINSON and D. P. MOON)
U. S. War Department
MAJOR HENRY L. RICE (Office Asst. Secy. of War) (1929)
(Alternate: CAPT. H. A. SKERRY)
Ex Officio
C. E. SKINNER

Socket-Head Cap and Set Screws

SOME months ago a group of four manufacturers of socket-head cap and set screws requested the Sectional Committee on the Standardization of Bolt, Nut, and Rivet Proportions to undertake the standardization of this type of screw. A preliminary canvass by correspondence convinced the Committee that the addition of this task to its present scope was generally desired. So Chairman A. E. Norton appointed a representative sub-committee to review the series of dimensions submitted by the manufacturers and to develop an American Standard for this product. This sub-committee, which is No. 9 of the Sectional Committee, held its organization meeting in New York on April 5, 1929. The personnel of this sub-committee, corrected to the date of the meeting, is as follows:

HERMAN KOESTER, *Chairman*, General Superintendent, The Bristol Company
JOHN S. COCHRAN, President, Mac-It Parts Company
ALBERT C. DANEKIND, Assistant to Manager, Schenectady Works, General Electric Company
EDWIN H. EHRMAN, Chief Engineer, Standard Screw Company
C. W. HOLLINGSWORTH, Sales Department, Standard Pressed Steel Company
WILLIAM J. OUTCALT, Standards Department, General Motors Corporation
W. A. PURTELL, The Allen Manufacturing Company
EDWARD M. WHITING, Vice-President, General Manager, Pheoll Manufacturing Company
VICTOR R. WILLOUGHBY, General Mechanical Engineer, American Car and Foundry Company. JOHN J. MCBRIDE, (Alternate)

The user interests as represented by the manufacturers of machine tools and other related industries are being requested to nominate additional persons for appointment on this sub-committee.

Correspondence

Wages of Engineers

TO THE EDITOR:

In Section 1 of the April issue of MECHANICAL ENGINEERING there is a letter from Thomas H. Normile on page 319. One statement in that communication may give a wrong impression to your readers.

Mr. Normile says: "Yet starting with this end in view [i.e., entering engineering], at least 50 per cent abandon engineering during the first twenty-five years after leaving school." According to the investigation of engineering education made in 1925–26, the percentage of graduates in mechanical engineering who are not in engineering fields is about 15.5 per cent. There are 22.3 per cent who are in "unassociated" lines of engineering, but engineering nevertheless. Either Mr. Normile has in mind a very narrow definition of engineering, or his figure is considerably in error.

This information will be found on page 4 of Bulletin No. 3 of the Society for the Promotion of Engineering Education, issued in October, 1926. Copies can be obtained from the Director in the United Engineering Societies Building.

R. L. SACKETT.[1]

State College, Pa.

A.S.M.E. Boiler Code Committee Work

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Below are given records of the interpretations of the Committee in Cases Nos. 619 and 620 as formulated at the meeting on February 8, 1929, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

CASE NO. 619

Inquiry: Is it permissible, under the Code for Low-Pressure Heating Boilers, to attach welded staybolts by pressing the plate into countersunk position rather than actually countersinking to within $^1/_{16}$ in. of the full thickness of the plate? All other details and dimensions of the welding process would conform to the requirements of Par. H-83 of the Code.

Reply: If the surface of the plate around the edge of the staybolt hole is depressed by a pressing operation which will conform the surface thereof to the countersunk form specified in Par. H-83 without removal of any metal, it is the opinion of the Committee that the requirements of this rule will be met.

CASE NO. 620

Inquiry: Was it the intent of Par. U-67 of the Code pertaining to welding processes, to eliminate the carbon-arc process of welding? The electric-arc process is referred to, but appears to be limited to the metallic-arc type using welding wire in connection therewith.

Reply: It is the opinion of the Committee that the term "electric-arc process," as used in Par. U-67, includes any electric process wherein the electric arc is used for fusing and where the metal is melted down or additional metal is deposited in making the weld.

[1] Dean of Engineering, The Pennsylvania State College. Mem. A.S.M.E.

Revisions and Addenda to Boiler Construction Code

IT IS THE policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision of the Rules and its Codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the Code, to be included later on in the proper place in the Code.

The Boiler Code Committee has received and acted upon a number of suggested revisions which have been approved for publication as addenda to the Code. These are published below, with the corresponding paragraph numbers to identify their locations in the various sections of the Code, and are submitted for criticisms and comment thereon from any one interested therein. Discussions should be mailed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Committee for consideration.

After 30 days have elapsed following this publication, which will afford full opportunity for such criticism and comment upon the revisions as approved by the Committee, it is the intention of the Committee to present the modified rules as finally agreed upon to the Council of the Society for approval as an addition to the Boiler Construction Code. Upon approval by the Council, the revisions will be published in the form of addenda data sheets, distinctly colored pink, and offered for general distribution to those interested, and included in the mailings to subscribers to the Boiler Code interpretation data sheets.

For the convenience of the reader in studying the revisions, all added matter appears in small capitals and all deleted matter in smaller type.

PAR. CA-5. REVISED:

CA-5. Cracks in riveted joints are generally attributable to steel of unsuitable quality, to excessive internal stresses in the plates caused by high riveting pressures, imperfect thermal or mechanical treatment during fabrication, unskilful or abusive treatment during the repair of leaky seams, also to extremely severe operating conditions. Cracks from such causes ARE, IN GENERAL, TRANSCRYSTALLINE IN CHARACTER AND OCCUR BOTH EXTERNAL OR INTERNAL TO ANY JOINT IN A BOILER [occur in riveted joints, both above and below the water level in boilers].

CRACKS OF A DIFFERENT CHARACTER OCCUR IN HIGHLY STRESSED PORTIONS OF A BOILER WHERE SALT CONCENTRATIONS TAKE PLACE. THESE CRACKS, WHICH ARE INTERCRYSTALLINE IN CHARACTER, ONLY OCCUR WITHIN RIVETED OR OTHER JOINTS AND ARE USUALLY TERMED "EMBRITTLEMENT."

IN ALL EMBRITTLEMENT CASES, THE ANALYSES OF THE CONCENTRATED BOILER WATER SHOW THAT THE SULPHATES ARE LOW IN PROPORTION TO THE COMBINED SODIUM HYDROXIDE AND SODIUM CARBONATE.

[The attention of the Committee has been called to the following exceptional cases in rivet joint cracks, described as intercrystalline in character and under the water level only: (a) Boilers in certain localities fed with well water containing sodium bicarbonate, but not an appreciable quantity of sodium sulphate (similar cracking has not been reported in the same localities in boilers fed with surface water free from sodium carbonate or containing sodium sulphate equal to or exceeding the sodium bicarbonate); (b) boilers fed with water in part composed of condensate from leaky caustic evaporators; (c) boilers fed with sea-water distillate to which compounds were added resulting in high concentrations of sodium alkalinity.]

IN ORDER TO INHIBIT THIS TYPE OF FAILURE [in view of the particular cases of embrittlement cited above] and pending further research, the maintenance of not less than the following ratio of sodium sulphate to the TOTAL [soda] methyl orange alkalinity is recommended [as a precautionary measure]:

Working Pressure of Boiler, Pounds Gage	Relation of TOTAL [Sodium Carbonate] alkalinity	to Sodium Sulphate
[0 to 150]	[1]	[to] [1]
BELOW 150	1	TO 2
150 TO 600, INCLUSIVE	1	TO 0.014 × STEAM PRESSURE
[150 to 250]	[1]	[to] [2]
[250 and over]	[1]	[to] [3]

EXAMPLE: WHERE BOILER PRESSURE IS 265 LB., THE RELATION IN THE BOILER CONCENTRATES SHOULD BE 265 × 0.014 OR 3.71 SULPHATE OF SODA TO ONE METHYL ORANGE ALKALINITY.

[Cracks of this particular character have not been reported in cases where water-softening equipment has been intelligently used, maintaining close control over boiler concentrations, and the boilers have been properly operated.]

IT IS ALSO RECOMMENDED THAT THE MENTIONED CONSTITUENTS BE DETERMINED BY THE STANDARD METHODS OF WATER ANALYSIS, PUBLISHED JOINTLY BY THE AMERICAN PUBLIC HEALTH ASSOCIATION AND AMERICAN WATER WORKS ASSOCIATION, 1925 EDITION.

Pending further operating data from boilers in service, it is recommended that the requirements of Par. I-44 of Section VI of the Code be extended to all riveted AREAS OR EXPANDED JOINTS [seams], and that careful examination of all seams be made if leaks occur and do not remain tight after proper calking.

PAR. P-195. REVISE SIXTH SECTION, AS PRINTED IN APRIL ISSUE, TO READ:

A blank head of a semi-elliptical form in which HALF the minor axis OR THE DEPTH OF THE HEAD [of the ellipse] is at least EQUAL TO ONE-QUARTER OF [one-half] the INSIDE diameter of the HEAD [shell], shall be made at least as thick as the required thickness of a seamless shell of the same diameter. If a flanged-in manhole which meets the Code requirements is placed in an elliptical head, the thickness shall be the same as for an ordinary dished head with a DISH radius equal to 0.8 the diameter of the shell and with the added thickness for the manhole.

WHEN HEADS ARE MADE TO AN APPROXIMATE ELLIPTICAL SHAPE, THE INNER SURFACE OF SUCH HEADS MUST LIE WITHOUT AND NOT WITHIN A TRUE ELLIPSE DRAWN WITH THE MAJOR AXIS EQUAL TO THE INSIDE DIAMETER OF THE HEAD AND ONE-HALF THE MINOR AXIS EQUAL TO THE DEPTH OF THE HEAD. THE MAXIMUM VARIATION FROM THIS TRUE ELLIPSE SHALL NOT EXCEED 1.25 PER CENT OF THE INSIDE DIAMETER OF THE HEAD.

PAR. P-260. REVISED:

P-260. Manhole frames on shells or drums shall have the proper curvature, and on boilers over 48 in. in diameter shall be riveted to the shell or drum with two rows of rivets, which may be pitched as shown in Fig. P-16. The strength of manhole frames and reinforcing rings ON ANY LINE PARALLEL TO THE LONGITUDINAL AXIS OF THE SHELL shall be at least equal to the tensile strength OF A CROSS-SECTIONAL AREA COMPUTED BY MULTIPLYING THE REQUIRED SHELL-PLATE THICKNESS (CALCULATED BY THE FORMULA IN [required by] Par. P-180 USING E EQUALS 1) BY the maximum LENGTH [amount] of shell plate removed by the opening plus the rivet holes for the reinforcement, on any line parallel

to the longitudinal axis of the shell through the manhole [or other] opening.

When a flanged manhole frame is used the flanged portion of the frame may be considered as reinforcement up to a height (h) of 3 times the flange thickness (see Fig. P-17).

PAR. P-261. REVISED:

P-261. The strength of the rivets in shear on each side of a frame or ring reinforcing manholes [or other openings such as those cut for steel nozzles and boiler flanges over 3 in. pipe size] shall be at least equal to the tensile strength (required by Par. P-180) of the maximum amount of the shell plate removed by the opening and rivet holes for the reinforcement on any line parallel to the longitudinal axis of the shell, through the manhole [or other] opening.

PAR. P-274. REVISED:

P-274. The minimum aggregate relieving capacity of all of the safety valve or valves required on a boiler shall be that determined on the basis of 6 lb. of steam per hour per sq. ft. of boiler heating surface for water-tube boilers. For all other types of power boilers, the minimum aggregate relieving capacity shall be that determined on the basis of 5 lb. of steam per hour per sq. ft. of boiler heating surface for boilers with maximum allowable working pressure above 100 lb. per sq. in., and on the basis of 3 lb. of steam per hour per sq. ft. of boiler heating surface for boilers with maximum allowable working pressures at or below 100 lb. per sq. in. In many cases a greater relieving capacity of safety valves will have to be provided than the minimum specified by this rule, and in every case the requirements of Par. P-270 shall hold.

The heating surface shall be computed for that side of the boiler surface exposed to the products of combustion, exclusive of the superheating surface. In computing the heating surface for this purpose, only the tubes, fireboxes, shells, tube sheets, and the projected area of headers need be considered. The minimum number and size of safety valves required shall be determined on the basis of the aggregate relieving capacity and the relieving capacity marked on the valves by the manufacturer. Where the operating conditions are changed, or additional heating surface such as water screens or water walls is connected to the boiler circulation, the safety-valve capacity shall be increased, if necessary, to meet the new conditions and be in accordance with Par. P-270. THE ADDITIONAL VALVES REQUIRED ON ACCOUNT OF CHANGED CONDITIONS MAY BE INSTALLED ON THE STEAM LINE BETWEEN THE BOILER AND THE MAIN STOP VALVE EXCEPT WHERE THE BOILER IS EQUIPPED WITH A SUPERHEATER OR OTHER PIECE OF APPARATUS, IN WHICH CASE THEY MAY BE INSTALLED ON THE STEAM PIPES BETWEEN THE BOILER DRUM AND THE INLET OF THE OTHER APPARATUS, PROVIDED THAT THE STEAM MAIN BETWEEN THE BOILER AND POINTS WHERE A SAFETY VALVE OR VALVES MAY BE ATTACHED HAS A CROSS-SECTIONAL AREA AT LEAST 3 TIMES THE COMBINED AREAS OF THE INLET CONNECTIONS TO THE SAFETY VALVES APPLIED TO IT.

PAR. P-296. REVISED:

P-296. *Steam Gages.* Each boiler shall have a steam gage connected to the steam space or to the water column or its steam connection. The steam gage shall be connected to a siphon or equivalent device of sufficient capacity to keep the gage tube filled with water and so arranged that the gage cannot be shut off from the boiler except by a cock placed near the gage and provided with a tee or lever handle arranged to be parallel to the pipe in which it is located when the cock is open. Gage connections which are filled with water AT A TEMPERATURE NEVER GREATER THAN THAT OF SATURATED STEAM AT A PRESSURE OF 250 LB. PER SQ. IN., OR 406 DEG. FAHR., shall be of brass, copper, or bronze composition. Connections that are filled with steam OR WATER OF A TEMPERATURE GREATER THAN THAT OF SATURATED STEAM AT A [shall for] pressure[s] OF [over] 250 lb. per sq. in. OR [and temperatures in excess of] 406 deg. fahr. SHALL be of steel pipe or of other material capable of safely withstanding the temperatures corresponding to the maximum allowable working pressure. Where steel or wrought-iron pipe connections are used they shall be not less than 1-in. pipe size.

PAR. U-74. REVISED:

U-74. *Dished Heads.* Dished heads convex to the pressure shall have a flange not less than $1^1/_2$ in. long and shall be inserted into the shell with a driving fit AND WELDED AS SHOWN IN FIG. U-3*K*. [in excess of the full length of the flange, welded to the shell with a V'ed weld, heated to the annealing point, the shell to be constricted on the end to a diameter not less than 1 in. smaller than the original diameter].

Dished heads concave to the pressure shall have a length of flange not less than 1 in. for shells not over 24 in. in diameter. For vessels over 24 in. diameter this length shall be not less than $1^1/_2$ in. It is, however, recommended that the length of flange shall be not less than 12 per cent of the diameter of the shell.

When the heads are thicker than the shell they shall be reduced in thickness as shown in Figs. U-3*J* or U-3*K*.

Section II General Revisions of Material Specifications

DURING the past year or two a number of revisions and modifications have been made in the various Material Specifications of the American Society for Testing Materials and it has been the desire of the Sub-Committee of the Boiler Code Committee on Material Specifications to bring the corresponding specifications in the Boiler Code into conformity therewith. Careful studies were made of the A.S.T.M. Specifications and those corresponding thereto in the A.S.M.E. Boiler Code, with the result that detail revisions are proposed in the following specifications and paragraphs thereof in order to bring about complete conformity:

- Specifications for Steel Boiler Plate, Pars. S-10, S-15, S-17
- Specifications for Gray-Iron Castings, Par. S-63
- Specifications for Malleable Castings, Pars. S-73, S-78
- Specifications for Boiler Rivet, Staybolt, and Extra-Refined Bar Iron, Pars. S-80, S-87, S-90
- Specifications for Wrought-Iron Pipe, Pars. S-133, S-141
- Specifications for Welded and Seamless Steel Pipe, Pars. S-110, S-111, S-112, S-114, S-119, S-123
- Specifications for Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes, Par. S-107
- Specifications for Copper Bars for Staybolts, Par. S-159
- Specifications for Carbon-Steel Castings for Valves, Flanges and Fittings for High-Temperature Service, Pars. S-221, S-226, S-228
- Specifications for Carbon-Steel and Alloy-Steel Castings, Pars. S-233, S-242, S-246
- Specifications for Steel Plate of Flange Quality for Forge Welding, Pars. S-264, S-274, S-276

Because of space limitations these revisions are listed in schedule form only and are not reprinted in full, since they are on record in the A.S.T.M. publications. Any one interested therein, who desires to obtain a record of the revisions in their complete form, may obtain them from A.S.M.E. headquarters.

The Conference Table

THIS Department is intended to afford individual members of the Society an opportunity to exchange experience and information with other members. It is to be understood, however, that questions which should properly be referred to a consulting engineer will not be handled in this department.

Inquiries will be welcomed at Society headquarters, where they will be referred to representatives of the various Professional Divisions of the Society for consideration. Replies are solicited from all members having experience with the questions indicated. Replies should be as brief as possible. Among those who have consented to assist in this work are the following:

ARCHIBALD BLACK,
Aeronautic Division
A. L. KIMBALL, JR.,
Applied Mechanics Division
H. W. BROOKS,
Fuels Division
R. L. DAUGHERTY,
Hydraulic Division
WM. W. MACON,
Iron and Steel Division
JAMES A. HALL,
Machine-Shop Practice Division
CHARLES W. BEESE,
Management Division
G. E. HAGEMANN,
Materials Handling Division
J. L. WALSH,
National Defense Division
L. H. MORRISON,
Oil and Gas Power Division
W. R. ECKERT,
Petroleum Division
F. M. GIBSON and W. M. KEENAN,
Power Division
WINFIELD S. HUSON,
Printing Industries Division
MARION B. RICHARDSON,
Railroad Division
JAMES W. COX, JR.
Textile Division
WM. BRAID WHITE,
Wood Industries Division

Management

The Gantt Chart in Drafting Rooms

MG-1 Has the Gantt chart ever found application in drafting rooms?

To answer this question directly, the writer must say that he does not know; however, he does know that there is no reason why it cannot be applied in this kind of work.

Wherever it is possible to plan in advance and to measure progress it is possible to use a Gantt progress chart to control the work. Of course, the more common applications are those where an activity is being carried out at a scheduled rate, and performance is easily measured in units of work accomplished. However, it has found applications in kinds of work which have similar elements to those found in drafting rooms.

Mr. Gantt made a practice of charting the progress of the installation of his methods, and Wallace Clark still does. For an example of such a chart, the reader is referred to a paper by Arthur E. Blackwood in the September, 1922, issue of *Management Engineering,* entitled "A Change in Management Methods Which Is Showing Satisfactory Results."

Another application which is quite similar has been used by the writer in charting the progress made by students in writing theses. This was presented in a paper by the writer read before the Association of Cooperative Colleges two years ago. Fig. 1 explains this application.

The inquirer is also referred to Wallace Clark's book, "The Gantt Chart," Ronald Press, and especially to chapters six and eight. (David B. Porter, Assistant Professor of Industrial Engineering, New York University.)

Materials Handling

Dust Collectors

MH-2 Centrifugal separators are being considered for installation in a dust-collecting system. Possible arrangements involve the use of one oversize separator or two small ones placed in tandem. Which arrangement is considered the better, and why?

Any collector in which centrifugal force is employed to effect dust separation depends for its efficiency on the centrifugal force developed on each dust particle. Accordingly, the factors which determine the intensity of this force will determine the relative efficiency of various sizes of centrifugal collectors. The formula for centrifugal force F in pounds is:

$$F = \frac{W}{G} \times \frac{V^2}{R}$$

where W = weight of the particle in pounds
G = 32.174

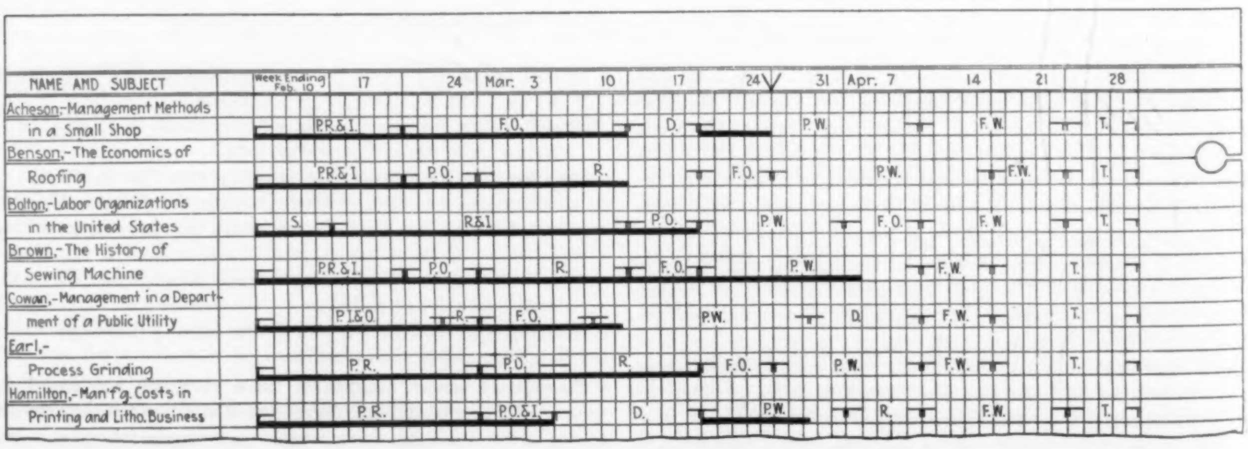

Fig. 1 Schedule and Progress of Thesis in Industrial Engineering

Key: D = drawings prepared; F = final; I = investigation; O = Outline; P = Preliminary; R = Reading; T = Typing; W = Writing.

V = tangential velocity
R = radius of rotation.

It will immediately be apparent that the efficiency varies as the square of the tangential velocity and inversely as the radius. Assuming two collectors having the same radius, then the higher the velocity of the entering gas, the higher will be the efficiency. Assuming two collectors having the same entering gas velocity, then the greater the radius, the lower will be the efficiency. This will explain why a miniature centrifugal collector will show a high efficiency, particularly if the gas is at a high velocity; but where the gas volumes are large, and the collector size necessarily increases, the efficiency rapidly drops off. It can therefore be stated that two smaller collectors arranged in parallel, each handling half of the total gas volume, would show better results than one large collector of the centrifugal type.

It must be borne in mind, however, that in any dust problem numerous other factors must be given careful consideration in order to obtain a satisfactory solution. The weight of the dust, its screen analysis, its structure, and other characteristics all have a decided bearing on the efficiency of collection regardless of the type of collector being considered. The same is true as regards the dust loading of the gases: that is, the grains of dust per cubic foot of gas. Because of these various factors it is never safe to recommend any particular type of dust collector without a thorough study of all conditions. While a centrifugal type may be entirely satisfactory in certain cases, it will fall far short of meeting the requirements where the dust particles are extremely fine and the dust loading light. Under these conditions it is preferable to use collectors employing some other principle of separation, of which there are numerous types available on the market. (W. A. Grobli, Dust Recovery, Inc., New York, N. Y.)

Power

STEAM TEMPERATURES[1]

P-1 What are the highest known temperatures for superheated steam, and for what purposes are they used?

This question was discussed in the June, 1928, issue of MECHANICAL ENGINEERING by R. M. Gates and R. P. Soule. In addition to the comments of these engineers, the following information appears in a paper by George A. Orrok on "High-Pressure and High-Temperature Steam," presented before the Midwest Power Conference, May 16, 1928.

"Four years' experience in continuous operation of superheaters raising the steam temperatures to 850 deg. fahr. with ordinary steel superheater tubes has proved such operation commercial, as no serious difficulties have been encountered." He points out that alloy steels for tubes, shells, and castings are available for more difficult operating conditions than have been heretofore tried out in practice, and that boiler companies state that they are ready to guarantee service to 900 deg. fahr. Temperatures as high as 1100 deg. fahr. have been reached, but not intentionally, and conditions were corrected as soon as possible after discovery. Perhaps discussion of this subject will bring out further details, especially as regards the use of alloy steels for tubes, shells, etc. (Editor).

Miscellaneous

SEALING GLASS PANELS IN DISPLAY REFRIGERATORS

M-6 In the manufacture of display refrigerators, what methods are employed to seal double-walled glass panels and doors to prevent infiltration of air between the panes and the consequent frosting of the glass?

[1] This subject has been discussed in a previous issue.

The air- and water-tight sealing of closed air spaces bound by glass plates of any thickness on the flat sides and by U-shaped grooved wooden or metal strips around the edges represents an opportunity to apply accurate workmanship, otherwise the dust and moisture leaking into such spaces through crevices will interfere with the permanent transparency of the glass panels. Such painstaking workmanship costs money, and so long as a display counter appears clean at the time of purchase, it is difficult for the fixture man to secure the price covering a more permanent job, and therefore slipshod work is not unusual.

To do the job right, the glass plates should enter the grooved edges for a distance at least equal to four thicknesses of the glass. Also, the pane of glass should be cut with edges perfectly square, straight, and true, so as to just fill the available space after an allowance of $^1/_{32}$ in. for cementing has been left all around the outside edge. It must be remembered that the work is usually done at room temperature, in which condition the plate of glass has its largest dimensions. When placed in service and cooled, the plate will contract; but even this contraction, for a 5-ft. length at 50 deg. fahr. cooling, amounts to but $^1/_{64}$ in.

To assist in making the grooves water-tight they should be coated throughout with either white lead, red lead, or—if black is not objectionable—emulsified asphalt, as used in the cork-insulation industry. Sometimes these materials are mixed, and any desired color added, also linseed oil. One should take care to apply only so much of this cement as will not become visible at the inaccessible inside of the air space.

The thickness of commercial panes of glass is not uniform, hence the use of cement is necessary to fill completely the kerf or U-groove into which the glass is placed. It should fit snugly, otherwise the joint will not be perfectly tight.

As a further precaution the air space should be closed up in a room containing dry air. In a well-equipped factory air dried by passing over lumps of calcium chloride would be blown with a bellows into the air spaces just before final sealing up.

Of course, the more air spaces used, the better the insulating effect, each space contributing its share of resistance to heat flow. Since the total temperature difference between the outside and the inside of a refrigerator is fixed and is distributed over the various spaces, the difference between opposite panes is reduced and therefore the tendency for condensation is eliminated. For these reasons, in high-class construction two or more air spaces are being used. As even then the heat loss is much more than through the solid insulation, the exposed glass area should be kept as small in extent as possible.

There is no appreciable difference in the insulating quality of thick and thin glass, but there is a slight gain in wide air spaces over thin ones.

By using alcohol or aqua ammonia, the glass panes can be made spotlessly clean before putting in place. (Charles H. Herter, Refrigerating Engineer, New York, N. Y.)

Question to Which Answers Are Solicited

BOILER-TUBE FAILURES

F-7 What specific instances can be quoted, when using distilled-water make-up, of the blistering or failure of boiler tubes directly exposed to the radiant heat of the furnace? Instances are desired either on the first two rows of boiler tubes, on the water walls, or on water screens, either with stoker, pulverized-fuel, or oil firing. Quote circumstances and method of eventual solution.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers, and Proceedings of

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Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

Mechanization of Armies

MILITARY experts throughout the world are immersed in a problem involving great differences of opinion between groups of tacticians, strategists, and even engineers. This problem is centered in the mechanization of armies, something more comprehensive than and quite different from mere motorization or the replacement of the horse by the internal-combustion motor. European armies have carried on exhaustive experiments and maneuvers. Relations between attacking power, speed and reliability of movement, and costs of equipment and maintenance have been studied, but, as in all similar problems, the answer in each country depends on the economic and industrial experience and resources of that country.

MECHANICAL ENGINEERING congratulates itself in being able to present in this issue a clear and unbiased statement dealing with the general problem of mechanization and relating in some detail the work done by our own Army.

Because of the great interest in this subject from the point of view of national defense generally and mechanical engineering in particular, letters thereon from members and readers of this publication will be welcomed, and if possible will be grouped at some later date.

Something Is Wrong

A LACK of appreciation of the kinds of service which engineers are competent to render and their importance to the prosperity of industrial undertakings foredooms many businesses to disaster.

While there is no lack of engineering brains and knowledge of how to adapt engineering principles to the problems of industry, many enterprises fail through causes which might have been completely guarded against or practices which run counter to the probability of success.

Something is wrong when knowledge and talent coexist with failure to make use of them. In spite of their activity in publication (the A.S.M.E. alone published during the past year more than 3500 pages of the size of this journal), the engineering societies and technical press have not succeeded in making executives sufficiently conscious of the developments in science, engineering, and technology. Even engineers themselves who should have a vital interest in these developments do not always know "what it's all about."

It was an attempt to do something constructive to improve this state of affairs that led to the publication of Part Two of MECHANICAL ENGINEERING, the single-sheet résumé in non-technical language which tells the reader "what it's all about." The Society's Publication Committee would like to know whether or not Part Two is a desirable feature of the journal, and what suggestions its readers may have for its development.

Heat Transmission

ATTENTION is drawn to the contributions on heat transmission to this issue. This important subject enters an incalculable number of problems in engineering, either because heat must be transmitted with efficiency and effectiveness, or because some form of insulation is necessary to prevent its wasteful or harmful flow. Boilers and condensers represent the first class of apparatus, pipe coverings and refrigerators the second.

The problems involved in the scientific study of the laws of heat transmission are particularly elusive, but as great economies may be effected by a correct solution of them, many researches have been made and are in progress. It was a desire to co-ordinate these investigations that led to the formation of the Committee on Heat Transmission of the National Research Council, of which Mr. W. V. A. Kemp, the Committee's director, writes in this issue.

Coincidently with this statement of the work of the committee, there appear two papers on heat insulation and transmission which are to be presented this month at the Rochester meeting of the A.S.M.E. These papers will be of great value in clarifying our ideas on the subjects in question and in helping designers in the solutions of their problems.

Flying Law

WHOLE codes of laws have been created to deal with various specific elements of our daily life in addition to the fundamental civil and criminal laws which in their broad features are common to all civilized countries. It is surprising to note how certain details have been thoroughly covered by law while others have not, but this depends of course on whether or not they involve the element of trouble. An illustration of this may be found in the fact that a code of laws has grown up about the dog, while there are practically no laws dealing with cats. It is only reasonable that this should be so, as cats generally stay at home, or when away attend strictly to their own business.

A legal structure more notable for its extent than beauty of logic has grown up about the automobile, and deals particularly with the right to operate it and responsibility for the various forms of damage which may be caused while operating it. One very serious feature of such automobile legislation is its lack of uniformity throughout the country, although as a rule a limited amount of reciprocity exists in that a license to operate granted by one state is honored in all other states of the Union.

Now that aircraft are becoming an important means of communication, nation-wide in range, it would appear to be par-

ticularly desirable to make an earnest attempt to unify state legislation regarding them. If this is not done a considerable burden will be imposed on the industry just as it has been imposed on the automobile industry through the variation in local laws. The airplane has not yet reached either the stage at which state legislators have become interested in it as a source of revenue, nor that further stage which was reached by the automobile at which they begin to treat it with respect. It is in this legislative twilight period that a concerted effort made to push uniform state legislation could be particularly successful.

In its experience with the Boiler Code, this Society has had opportunity to observe that the Uniform Boiler Law Association in impartially proposing laws helpful broadly to industry, has received respectful attention from legislative bodies. This suggestion is made with confidence, as there is no obvious reason why rules governing aircraft construction and operation should not be reasonably uniform in all states.

General Knowledge of the Properties of Steam

SCIENTIFIC data and facts recognize allegiance to no laboratory, no city, nor country. Since the advent of the industrial use of steam by man, which has been but a little over 100 years, the scientific workers of all lands have labored day and night to build up the body of exact knowledge of nature's laws which now makes possible our engineering practice and the present industrial age.

On another page of this issue will be found a brief review of the organization and the activities of the committee in charge of the Society's research on the physical properties of steam. This account begins with the preliminary informal conference held at the Massachusetts Institute of Technology in June, 1921, and traces the principal events in connection with this research in the United States up to the present time.

During this period and before, similar researches are known to have been in progress in Great Britain, Germany, Switzerland, and Czechoslovakia, and the A.S.M.E. Committee has endeavored to keep in close touch with the progress made in these countries. The importance of this investigation to the industries concerned in the generation of steam power is generally recognized, and more and more it is being realized that international agreements on accepted values for certain of the experimental data would be most helpful to the scientists and engineers to whom will fall the task of developing the steam tables and chart in the several countries.

The Society's Committee is in entire sympathy with this point of view and has always encouraged interchange of data and results. The publication in Mechanical Engineering of papers and reports by the experimenters at work under its auspices for the past six years gives all necessary support to this statement. The similar publications, of data in the technical journals of the other interested countries have been largely read and greatly appreciated in the United States. The A.S.M.E. Committee has gone further and placed itself on record in favor of international agreements on the principal values establishing the new steam tables which will result from this research.

The time now seems ripe for informal conferences of the workers on the physical properties of steam. In fact, the British Committee has already invited this group to assemble in London during the week immediately following the proposed meeting of I.E.C. Advisory Committee No. 5 on Steam Turbines, July 1 to 6, 1929, and the American workers are planning a conference at Stevens Institute of Technology in April, 1930. The reorganized A.S.M.E. Committee on the Physical Properties of Steam will consider ways and means of carrying on and completing this important investigation.

Recent German Shipbuilding

THE end of the World War saw Germany practically deprived of its war navy and at the bottom of the list of great nations in the matter of merchant marine. Any one conversant with the psychology of the German people could not but look forward to a reconstruction of both of these branches of navigation to the very limit of what their country would be permitted to do. Such an expectation has not been unfulfilled.

In the merchant-marine field the German companies profited by the low cost of the mark before the introduction of the Dawes plan, and, one of them, at a cost of some $30, rid itself of bonded indebtedness amounting to millions of marks. This left their capital structure in a very favorable condition and, when things began to look up in the country, permitted them to start new construction. While comparatively little is known concerning the details of this construction, what has been published would indicate that mechanically the new vessels represent the very last word in marine engineering, all tradition having been ruthlessly cast aside. As a sample of this departure from the beaten path may be mentioned the stern construction of the new ships. In fast cruisers the beautiful streamline stern was abandoned long ago, it having been found that a straight stern in a boat with sufficient propelling power gives as good if not better results than the type inherited from the sailing vessel, costs less to build, and provides a somewhat more rigid structure. The merchant-marine vessels, however, including the huge, recently built British ships, stuck to the traditional form. But the Germans have now cast it aside and given their new ocean greyhounds a clear cruiser shape.

In the navy field considerable attention has been attracted to the new German cruiser, the *Ersatz Preussen*, which is remarkable for several things such as its very large cruising radius, but particularly for its armament which consists of 11-in. guns. As under the Treaty of Versailles a cruiser cannot exceed 10,000 tons, it ranks in displacement with the so-called Treaty cruisers limited to the same tonnage by the Washington Peace Conference of 1921. The Washington Conference, however, limited also the size of the gun to 8 in., with the result that unit for unit the German cruiser is vastly superior to any of the Treaty cruisers built or building since the Washington Conference. The military value of such a cruiser, even when but one or two of them are available, is such that it cannot be neglected. Of course, two of these superior cruisers could not successfully fight off the large number of British Treaty cruisers, but there is no reason to expect that the commander of the *Ersatz Preussen* would be foolish enough to attack or let himself be attacked by such superior forces. In case of war the *Ersatz Preussen* would of course be used to raid the enemy's merchant marine and troop ships, or might be operated in connection with submarines to convoy vessels. It could do this very well, too, because it has a heavier armament than any vessel equal to it in speed, and can outrun any other vessel superior to it in armament. Just what influence this will have on the status of the part of the Washington Conference affecting cruiser construction, remains to be seen.

Employment in "Middletown"

THE contemporary life of "Middletown," an industrial city in the Middle West whose actual name is not stated, has recently been revealed in an investigation made under the auspices of the Institute of Social and Religious Research. A staff of five spent part of a year and a half studying the six main life-activities of the people in this city, selected as representative of contemporary American life and as a compact and homo-

geneous sample for total-situation study. The book "Middletown" issued after three years' analysis of the results of the study, tells how the people get their living, make their homes, train their young, use their leisure, engage in religious activities, and participate in community work. As a case presentation this book is invaluable to the various groups of students in sociological fields. To engineers, it gives tangible evidence of the social and economic effects of engineering processes. Its discussion of the continuity of employment is exceedingly interesting, and brings home facts often lost or easily forgotten.

The impression generally prevails that except in periods of extreme unemployment any man in the industrial section of the United States who wants to work can get a job quickly and need not be out of work except for short periods. "Middletown," however, presents figures which give pause to this prevailing confidence in the availability of jobs. To quote:

Among the working class, however, the business device of the "shut-down" or "lay-off" is a recurrent phenomenon. If the number of workingmen employed in seven leading Middletown plants on June 30, 1920, be taken as 100, the number allowed to get a living on December 31, 1921, was sixty-eight; on December 31, 1922, ninety-three; on June 30, 1923, 121; on December 31, 1923, 114; on June 30, 1924, seventy-seven; on December 31, 1924, sixty-one; on June 30, 1925, eighty-one. The month-by-month record of one of these plants, a leading machine shop, during 1923, again taking the number employed on June 30, 1920, as 100, was:

January...	61	May.....	117	September...	57
February..	75	June.....	92	October......	48
March.....	93	July......	66	November...	43
April......	110	August...	63	December....	46

In one leading plant 1000 is regarded as the "normal force." When interviewed in the summer of 1924, about 250 men were actually getting a living at this plant, though the bosses "think of about 550 (of the normal 1000) as our men." The other 450 are floaters, picked up when needed. In another large plant the number of men employed on December 31, 1923, was 802, and six months later, June 30, 1924, was 316, but only 205 of these men worked continuously throughout the entire six months with no lay-offs.

Of the sample of 165 working-class families for whom data on steadiness of work were secured, 72 per cent of the male heads of families lost no time at work in the twelve months of 1923 when "times were good," another 15 per cent lost less than a month, and 13 per cent lost a month or more; during the first nine months of 1924, throughout the last six of which "times were bad," only 38 per cent of the 165 lost no time, another 19 per cent lost less than a month, and 43 per cent lost a month or more. Among the forty families of business men interviewed, only one of the men had been unemployed at any time during the two years, 1923–1924—and that was not due to a lay-off.

This leads the authors of "Middletown" to the conclusion, supported by statements of the wives of workingmen, to the effect that to the workingman unemployment as a "problem" varies from a cloud the size of a man's hand when times are good, to a black pall in a time of easy labor market that may overspread all the rest of their lives. Steady work appears to be generally valued by the older workers above high wages, and one of the features of unemployment is the suddenness with which it comes down at times, cases being cited where not even the foreman knew the lay-off was coming. It is a sad picture at best that such conditions can be possible at a time assumed to be one of general prosperity.

The commonest working-class solution of the problem of unemployment is to "get another job."

Failing in finding another chance to get a living, the whole family settles down to the siege. Of 122 housewives who have information regarding readjustments occasioned by unemployment, eighty-three reported unemployment during the preceding fifty-seven months. Sixty-eight, the great majority of those reporting unemployment, had made changes in their routine habits of living to meet the emergency. Of these, 47 cut on clothing; 43 cut on food; 27 of the wives worked for pay either at home or away from home; 14 of the 60 carrying some form of insurance got behind on payments; 6 moved to a cheaper home; 5 of the 20 having a telephone had it taken out; 4 of the 35 with children in high school took a child from school.

To an engineer, plant manager, and even a plant owner, such a situation as is apparently truthfully described above is anything but attractive. A free labor market, which means labor always available, is an advantage from the point of view of wages, and perhaps tendency of the men "to be good." On the other hand, it does not create a state of mind that contributes to best results. If we agree with such men as Henry Ford that labor is not only the producer of commodities but to a great extent the consumer thereof, a situation where men are living on the ragged edge under constant threat of prolonged unemployment is again not one to create a good market for commodities. It would appear, therefore, that either employment conditions in "Middletown" are exceptionally unsatisfactory, or that under a dazzling cloak of apparent prosperity conditions exist which deserve the most serious and immediate consideration. If conditions are truly such as those described occurred in 1924–1925 when the majority of our industries were breaking all previous records of production, what are they likely to be should we pass through one of those periods of industrial depression which after all we have not probably as a country completely left behind us?

The Knoxville Meeting

SELDOM has a gathering of mechanical engineers been received with the sympathetic understanding of public officials, leaders of commerce and industry, and the daily press that greeted and surrounded the meeting of the Society in Knoxville, Tennessee, on March 21, 22, and 23. This attitude of the leaders of thought of a goodly portion of a great state was founded on a thorough appreciation of the part engineers have played in a comparatively young industrial area, the evidence of which is easy to find. In Knoxville, an active club of engineers gives constructive help in the solution of municipal problems, and a splendid engineering faculty at the state university is solving problems of state development. The achievements of these men in their daily tasks and in their attack on public problems have been instrumental in securing the public recognition which was so thoroughly revealed during our meeting.

The program of papers and the discussion demonstrated clearly that the engineers and the engineering teachers of the South are alert to its tremendous problems. In subject-matter the papers ranged from technical research to practical determinations of the best methods for utilizing the resources of men and materials in the region. The keen interest shown in the technical program is supreme evidence that the Society should continue its present policy of frequent sessions in the South.

The enthusiasm of the meeting was undoubtedly helped by the large body of students who attended. A student engineering association which met simultaneously conducted some of the events in a fashion that in certain details overshadowed the more technical activities of the grown-ups. The Society should encourage more meeting events of this kind.

Two stimulating addresses featured the meeting. In one, L. W. Wallace, secretary of the American Engineering Council, dealt with the leadership of engineers. He showed the range and scope of the influence that the engineering type of mind exerts on the fundamental activities of modern civilization. Ralph E. Flanders, one of the managers of the Society, discussed the factors which differentiate civilizations.

The Knoxville Meeting goes into the record as an enthusiastic gathering marked by a good technical program, thought-provoking addresses, and a marked appreciation by the public of the work of the engineering profession.

Ferdinand Foch—Marshal of France

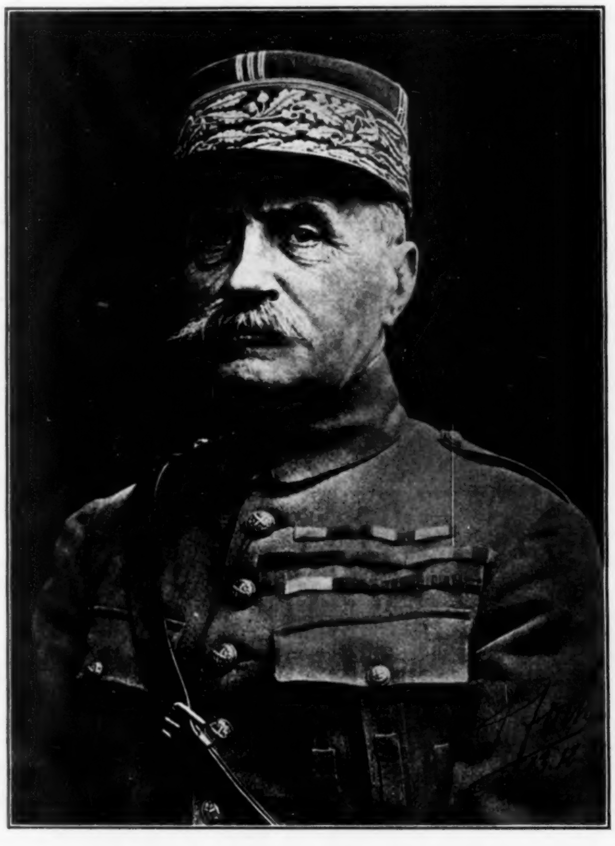
Generalissimo of Armies of the Allies Was an Honorary Member of Civil, Mining and Metallurgical, Electrical, and Mechanical Engineers

FERDINAND FOCH, Marshal of France, died in Paris on March 20. An illness which had been stubbornly fought with soldierly determination and characteristic optimism ended suddenly and peacefully in a heart attack. Thus passed one of the great generals of history who had commanded the Armies of the Allies during the dark days of March, 1918, and who had met in November of that year in the historic railway car in the Forest of Compiègne the German envoys who had come to arrange terms for an armistice.

Marshal Foch was born on October 2, 1851. His father was a civil servant under the regime of the Second Empire, and his grandfather had been a general under the great Napoleon. The outbreak of the Franco-Prussian war found him at school in Metz where his family was then living. After seeing the Germans at Metz the thought of revenge became fixed in his mind, and he concentrated the efforts of his entire life on the preparation of France for what he considered would be an inevitable war.

With an aptitude for mathematics, but without any apparently marked genius for so stupendous a task as he had set for himself, he began his military career. Following his services as a subaltern in the war of 1870, he entered the École Polytechnique in 1871, from which he was graduated into the artillery, forty-fifth out of a class of seventy. In 1875 he was commissioned a captain of artillery and nine years later entered the École de Guerre as a student. In 1896 he became professor of strategy and general tactics at the war college and in 1907, after some time spent with his regiment, he returned as Director of the École de Guerre at the request of Premier Clemenceau. His lectures are published in two books, "The Conduct of War," and "The Principles of War." He was regarded as a theorist and philosopher and a mathematician of a high order, but it was not until the beginning of the Great War that the French realized that in Foch they had a great military leader.

"The moral factor is the most important element in war," Foch wrote, "the will to conquer sweeps all before it. There is a psychological phenomenon in great battles which explains and determines their results. One hundred thousand men leave 10,000 of their number dead upon the ground and acknowledge themselves beaten; they retreat before the victors who have lost as many men, if not more. Neither one side nor the other side knows when they withdraw what its own losses have been nor how heavy those of the opposing force; therefore, it is not on account of material damage, still less from any possible computation of figures, that the losers give up the struggle."



FERDINAND FOCH—MARSHAL OF FRANCE

Foch introduced a new conception into the art of warfare. It was not, he maintained, an exact mathematical science, but an art in the application of which it was absolutely necessary to have a fundamental knowledge of general principles.

The inevitable war for which he had prepared himself came in 1914. On May 15, 1917, he became Chief of Staff of the Army of France and technical adviser to the government. On March 25, 1918, he was made Generalissimo of the Armies of the Allies, and in August of the same year, Marshal of France.

The part played by Foch in the World War is a matter of historical record. His genius as a general must be appraised by students of military science competent to undertake such an evaluation. The dramatic scenes in the Forest of Compiègne were a climax to the career which he had devoted to the service of France. "Mr. President," he said to Clemenceau when he returned to Paris, "my work is finished. Your work begins." The soldier's work gave way to the statesman's.

On December 13, 1921, at the completion of a tour of the United States as guest of the American Legion, Marshal Foch was made an honorary member of the four National Engineering Societies, the A.S.C.E., the A.I.M.E., the A.S.M.E., and the A.I.E.E. Unanimously, the governing bodies of these societies aggregating 45,000 members conferred this signal honor, the only one of its kind, in expression of the "appreciation of American engineers for the unmatched services of this master of engineering principles, cooperation and coordination." At the ceremonies, an engrossed certificate, signed by the presidents and secretaries of the societies, was presented to Marshal Foch.

Beneath the portrait plaque of Ferdinand Foch which is set in the east wall of the foyer of the Engineering Societies Building in New York, hangs a laurel wreath in honor of the dead Marshal of France. In Paris, at the time of his funeral, another wreath expressed the respect which the engineers of this country held for the man whom they had honored, and the sorrow which they shared with the rest of the world in his passing.

Slotted-Head Proportions Standards for Machine, Cap, and Wood Screws

THE proposed American Standard for Slotted-Head Proportions is the sixth standard developed by the Sectional Committee on the Standardization of Bolt, Nut, and Rivet Proportions to be submitted to the sponsor organizations. This proposal covers the dimensions for flat, round, fillister, and oval-head screws.

It will be recalled that the Sectional Committee on the Standardization of Bolt, Nut, and Rivet Proportions was organized in March, 1922, by the Society of Automotive Engineers and The American Society of Mechanical Engineers as joint sponsors under the procedure of the American Standards Association. The desirability of standardizing the head dimensions of Slotted-Head Screws was recognized with the inception of the Sectional Committee, and Sub-Committee No. 3 held its first meeting in December, 1922.

The sub-committee reviewed and collated all existing specifications and practices during its numerous meetings throughout the country, and many copies of the proposal in tentative form were distributed for the purpose of obtaining criticism and comment in the course of its development.

The proposed standard for Slotted-Head Proportions has been approved by the Sectional Committee and is now submitted to the sponsor organizations for approval. Accordingly, as one step in the A.S.M.E. procedure for approval, there are reproduced herewith several typical tables of the proposed standard dimensions for the information of our readers. Those who are especially interested in this subject to the extent of making a critical review may secure a copy of the complete report by addressing Mr. C. B. LePage, Assistant Secretary, A.S.M.E., 29 West 39th Street, New York, N. Y.

Fillister Head Cap Screws

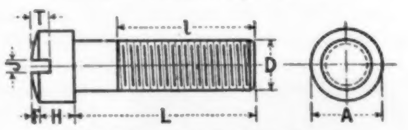


Table No. 8 Head Dimensions

Nominal Size	D	A		H		J		T		F		F+H	
	Max. Diameter	Head Diameter		Height of Head		Width of Slot		Depth of Slot		Height of Oval		Total Height of Head	
		Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
1/4	.250	3/8	.363	11/64	.157	.070	.058	.097	.077	.044	.038	.216	.195
5/16	.3125	7/16	.424	13/64	.186	.079	.065	.115	.090	.050	.044	.253	.230
3/8	.375	9/16	.547	1/4	.229	.088	.074	.142	.112	.064	.056	.314	.285
7/16	.4375	5/8	.608	19/64	.274	.098	.083	.168	.133	.071	.063	.368	.337
1/2	.500	3/4	.731	21/64	.301	.110	.094	.188	.148	.084	.075	.412	.376
9/16	.5625	13/16	.792	3/8	.347	.123	.106	.214	.169	.091	.081	.466	.428
5/8	.625	7/8	.853	27/64	.392	.138	.119	.240	.190	.099	.088	.521	.480
3/4	.750	1	.976	1/2	.466	.154	.134	.283	.233	.112	.100	.612	.566
7/8	.875	1 1/8	1.098	19/32	.556	.173	.151	.334	.264	.126	.113	.720	.669
1	1.000	1 5/16	1.282	21/32	.613	.194	.170	.372	.292	.146	.131	.802	.744

All dimensions in inches.

The unthreaded body diameter of Cap Screws will have the same tolerances as the major thread diameter shown in the American National Standard Screw Threads. Class 2 Free Fit, where the number of threads per inch are the same.

Round Head Machine Screws

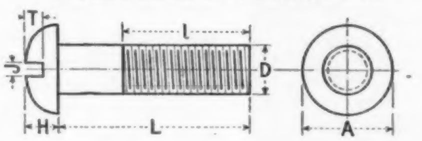


Table No. 2 Head Dimensions

Nominal Size	D	A		H		J		T	
	Max. Diameter	Head Diameter		Height of Head		Width of Slot		Depth of Slot	
		Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
2	.086	.162	.146	.070	.059	.036	.024	.042	.036
3	.099	.187	.169	.078	.067	.038	.026	.053	.040
4	.112	.211	.193	.086	.075	.040	.028	.058	.043
5	.125	.236	.217	.095	.083	.043	.031	.062	.047
6	.138	.260	.240	.103	.091	.045	.033	.067	.050
8	.164	.309	.287	.119	.107	.050	.037	.076	.057
10	.190	.359	.331	.136	.124	.055	.041	.086	.064
12	.216	.408	.382	.152	.140	.059	.045	.095	.071
1/4	.250	.472	.443	.174	.161	.066	.051	.108	.080
5/16	.3125	.591	.557	.214	.200	.077	.061	.130	.097
3/8	.375	.708	.670	.254	.239	.088	.072	.153	.114

All dimensions in inches.

The unthreaded body diameter of machine screws will have approximately the same tolerances as the pitch diameter of the threads shown in the American National Standards Screw Threads, Class 2 Free Fit, where the number of threads per inch are the same.

Flat Head Wood Screws

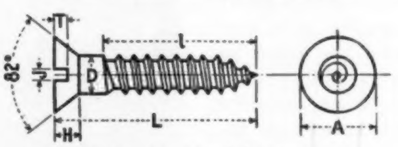


Table No. 10 Head Dimensions

Screw Number	D	A		H		J		T	
	Diameter	Head Diameter		Height of Head		Width of Slot		Depth of Slot	
		Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
0	.060	.119	.105	.035	.026	.031	.020	.015	.010
1	.073	.146	.130	.043	.033	.033	.022	.019	.012
2	.086	.172	.156	.051	.040	.036	.024	.023	.015
3	.099	.199	.181	.059	.048	.038	.026	.027	.017
4	.112	.225	.207	.067	.055	.040	.028	.030	.020
5	.125	.252	.232	.075	.062	.043	.031	.034	.022
6	.138	.279	.257	.083	.069	.045	.033	.038	.024
7	.151	.305	.283	.091	.076	.047	.035	.041	.027
8	.164	.332	.308	.100	.084	.050	.037	.045	.029
9	.177	.358	.334	.108	.091	.052	.039	.049	.032
10	.190	.385	.359	.116	.098	.055	.041	.053	.034
11	.203	.411	.385	.124	.105	.057	.043	.056	.037
12	.216	.438	.410	.132	.112	.059	.045	.060	.039
14	.242	.491	.461	.148	.127	.064	.050	.068	.044
16	.268	.544	.512	.164	.141	.069	.054	.075	.049
18	.294	.597	.563	.180	.155	.074	.058	.083	.054
20	.320	.650	.614	.196	.170	.078	.062	.090	.059
24	.372	.756	.716	.228	.198	.088	.071	.105	.069

All dimensions in inches.

Tolerance in diameter (D) + 0.004 to — 0.007 inches.

Probability and Its Engineering Uses

By I. Gutmann,[1] New York, N. Y.

Engineers are generally apprised of important developments in pure science by scholars of their own fraternity who do the scouting and indicate the practical implications of the new knowledge. Thus, the late Steinmetz left us a book on the theory of relativity.

The volume before us,[2] exemplifies the less usual procedure of an adept of pure science (Dr. Fry is a mathematician engaged in industrial work) expounding his theoretical science and its practical uses to prospective and to practicing engineers. To judge by this example, the net result may prove highly stimulating and fruitful, principally because the pure scientist is obviously apt to be more critical and more appreciative of the limitations of scientific theory.

Dr. Fry's textbook "is the outgrowth of a set of notes originally prepared for one of the "out-of-hour courses" of the Bell Telephone Laboratories, and subsequently revised for use in a course of lectures delivered at the Massachusetts Institute of Technology in its Department of Electrical Engineering. The book is divided into eleven chapters of which the first nine, taking up 320 pages, treat of the theoretical principles of probability methods. Chapter X, 68 pages, illustrates the applications of probability methods to the study of problems of telephone traffic. Chapter XI, 35 pages, indicates the use of probability and statistical mechanics in problems of pure physics such as the kinetic theory of gases, the Schottky effect, etc. The appendices consist of 45 pages of mathematical tables.

A book of this structure and apportionment of space could have been more justifiably named "Probability for Telephone Engineers." This is said in a spirit of envy, for it is a pity that we, of other enginering denominations, are left out in the cold when it comes to the practical engineering uses of probability. It is a pity that the author does not illustrate the uses of probability in the study of stream flow, water storage, and other equally important engineering problems.

Of course, the theoretical part, which is the bulk of the book, can be studied with great profit by all engineers who have the requisite time and serenity of mind. The presentation of the theory is critical and modernly skeptical. Its rather unusual logical rigor, which can be only instinctively appreciated by engineers, apparently taboos the use of a number of rather familiar old-time terms such as frequency, law of error, etc., and an engineer who studied least squares or statistical theory in his youth may at first feel in unexpectedly strange and chilly surroundings.

The stimulating and fruitful effect of the book, alluded to in the second paragraph of this review, may prove to reside in the author's wholesome criticism of the method of least squares. To engineers least squares and probability are practically synonymous, and the criticism has been sorely needed ever since engineers began to use the method of least squares in problems other than the adjustment of instrument measurements. Now, the Gaussian normal law of error, which is the very foundation of the method of least squares, says the author, "is, in a sense at least, venerable principally for its age. It has its uses, but it is not divinely ordained for the cure of all statistical woes." Furthermore, "experience has taught that very few sets of experimental data appear to follow the law." Of course this criticism is neither original nor new; the method of least squares has been criticized almost since its birth, but the platform and the audience are new. Nor is the criticism as extreme as it may seem. In his remarkable "Treatise on Probability," Mr. Keynes wrote that our bible on least squares, Prof. Mansfield Merriman's textbook, "opens with a series of very fallacious statements." It has long been recognized by mathematicians and statisticians that the Gauss law of error is applicable only in the case of errors of precision measurements with delicate instruments in the hands of carefully trained observers. It is an excellent method of approximation for the reduction of astronomical, geodetic, and laboratory measurements, but it is purely dogmatic and futile to attempt to apply it to the study of, say, meteorological, or hydrological phenomena, conditions of traffic, production control, etc. Engineers of great renown sinned in this, and it is time to realize that the trouble is not with the data which may be insufficient, but with the dogma which is misapplied. Let us hope that Dr. Fry's book will effect this realization.

Book Reviews and Library Notes

Books Received in the Library

Air Navigation and Meteorology. By Capt. Richard Duncan. Koppel Publishing Co., New York, 1928. Bound, 5 × 7 in., 136 pp., illus., diagrams, $3.50.

A concise text on the use of maps and charts, the compass and other instruments in piloting aircraft, and on the rudiments of meteorology. The author confines himself to matters of interest to fliers.

Aeolus; or, The Future of the Flying Machine. By Oliver Stewart. E. P. Dutton & Co., New York, 1928. Cloth, 4 × 6 in., 91 pp., $1.00.

A brief discussion of the future of civil and military flying machines and of the airship. The author has decided views on many disputed points, and his little essay will interest every one connected with aviation.

Begrenzung der Leistungssteigerung der Schnellaufenden Verbrennungsmachine durch den Steuervorgang. By Manfred Christian. (Forschungsarbeiten, heft 315.) V.D.I. Verlag, Berlin, 1929. Paper, 9 × 12 in., 19 pp., diagrams, tables. 3.75 r.m.

An investigation of the attainable limit of speed for high-speed internal-combustion engines, such as those used for automobiles and airplanes, and especially of the extent to which this limit is fixed by the capabilities of the valve gear. The author investigates the various valve-gears which have been applied to four-cycle engines and determines the highest speeds possible for various sizes. Sleeve valves and rotary valves, he concludes, offer no hope for speeds higher than those which are obtainable by the use of ordinary valves.

[1] Associate Editor, A.S.M.E. Engineering Index Service.

[2] "Probability and Its Engineering Uses," by Thornton C. Fry, Ph.D. D. Van Nostrand Co., Inc., New York, 1928, xiv + 476 pp., 49 figures, tables, $7.50.

Dampfturbinen. By Leonhard Roth. R. Oldenbourg, Berlin, 1929. Paper, 7 × 10 in., 103 pp., diagrams, tables. 6 r.m.

Dr. Roth gives a concise presentation of the principles of the design and construction of steam turbines from which advanced mathematics is absent. Starting with a description of the principles of the turbine, he develops the design of the various parts, and then the combination of these into a complete machine. Modern tendencies in design and modern constructions are discussed.

Design, Construction and Maintenance of Docks, Wharfs and Piers. By F. M. Du-Plat-Taylor. Ernest Benn, London, 1928. Cloth, 8 × 10 in., 495 pp., illus., plates, diagrams. 70 s.

This work is intended for engineers and managers of docks and harbors, and is confined mainly to practical considerations. The author writes from an experience of thirty years as a dock and harbor engineer in England, and has produced a valuable addition to the literature.

After an interesting chapter on ancient harbors, the book discusses organization and management, forms of docks, dock and wharf walls, jetties, drydocks, machinery, buildings, dredging construction, and maintenance. An abundance of plates and drawings illustrate the work and show practice at many important harbors.

Dictionary of American Biography. Under the Auspices of the American Council of Learned Societies. Edited by Allen Johnson. Charles Scribner's Sons, New York, 1928. Cloth, 7 × 10 in., 20 vols. $250.00 per set.

Early in the present century there developed among the learned societies of America a serious discussion of ways and means of bringing into being a dictionary of American biography which would be, for students of America, what the Dictionary of National Biography is to their colleagues in Great Britain. An organization was effected, Adolph S. Ochs provided a half-million dollars for editorial work, and actual preparation of copy was begun in 1925.

The managers of the work plan to include biographies of all former inhabitants of America who have made "some outstanding contribution to the tradition of America." Unusual effort has been made to make the list of names complete and to include in it certain classes who are too often neglected in works of this character.

The first volume, a handsomely printed book of 660 pages, begins with Cleveland Abbe, astronomer and meteorologist, and ends with Maurice Barrymore, actor. The first engineer to appear is Brig.-Gen. Henry L. Abbot, well known for his important early work on hydraulics and the regimen of the Mississippi River; the last is Joseph Barrell, the geologist and teacher at Lehigh and Yale.

Between these extremes are recorded the lives of forty-four other engineers and manufacturers. Among them are such men as John F. Appleby, who invented the knotter used on most grain reapers; the metallurgists Albert Arents and Philip Argall; Isaac Babbitt, of babbitt-metal fame; the Loammi Baldwins, father and son; Mattheas W. Baldwin; Albert Ball; and Zenus Barnum, prominent in the organization of early telegraph lines, but best known as the proprietor of the famous Barnum's Hotel in Baltimore.

Others of note are Horace Abbott, who rolled the armor-plate for the *Monitor;* Alexander Agassiz; James P. Allaire, the engine builder; Horatio Allen and John F. Allen; John R. Anderson, whose Tredegar Iron Works was the backbone of the munitions supply of the Confederacy; Oakes Ames and Oliver Ames; and David Alter, the pioneer physicist.

Each biography is written by a competent authority, and the sources for the statements are given. The standard is high and as it undoubtedly will be maintained through the remaining volumes, the dictionary will be in the first rank of indispensable works of reference.

It is planned to be completed in twenty volumes, containing 16,000 biographies.

Diesellokomotiven. By G. Lomonossoff. V.D.I. Verlag, Berlin, 1929. Cloth, 9 × 12 in., 304 pp., illus., diagrams, plates, tables. 32 r.m.

Professor Lomonossoff gives in this volume a very able study of the present position of the Diesel locomotive. The evolution of the machine, its theory and construction, are discussed in the light of the researches of the author and his colleagues, and current practice is subjected to keen critical investigation. The various types of transmission are discussed at length.

Die Durchflusszahlen von Normaldüsen und Normalstaurändern für Rohrdurchmesser von 100 bis 1000 Mm. By M. Jakob and Fr. Kretzschmer. (Forschungsarbeiten, heft. 311.) V.D.I. Verlag, Berlin, 1928. Paper, 9 × 12 in., 35 pp., illus., diagrams, tables. 5.50 r.m.

The accuracy of the common method of measuring large flows of fluids, by means of flow through orifices, depends upon a coefficient of flow which varies with the shape of the orifice. The present bulletin gives the results of an elaborate investigation to determine correct values for the coefficients of flow through the large sizes of German standard nozzles and plate orifices. The coefficients were determined within one per cent, and the results are applicable to air, superheated steam and other gases.

Economics of Water Power Development. By Walter H. Voskuil. A. W. Shaw Co., Chicago and New York, 1928. Cloth, 5 × 8 in., 225 pp., diagrams, maps, tables. $3.

The author has attempted to analyze the factors that govern the economic exploitation of water-power resources. He first lays down the principles of water-power economy, calling attention to the elements of cost. The water powers of various sections of the United States are then discussed, after which the public control of water powers and the various projects for public ownership are taken up. Much statistical material is summarized and a good bibliography is given.

Les Engrenages. By Raymond Mignée. Dunod, Paris, 1929. Paper, 7 × 10 in., 286 pp., diagrams, paper. 59.60 fr.

A practical treatise on gear design, gear cutting, and automobile gears. The author considers theory, as well as practice, and is successful in presenting the subject clearly and concisely.

Handbook of Hydraulics. By Horace Williams King. Second edition. McGraw-Hill Book Co., New York, 1929. Fabrikoid, 4 × 7 in., 523 pp., diagrams, tables. $4.

This book is intended primarily to assist in the solution of hydraulic problems, and presupposes a knowledge of the principles of hydraulics. The author discusses the formulas used and presents a great amount of tabulated data that will simplify calculation.

The new edition extends the application of the Manning formula to flow in pipes. A new chapter on critical depth and hydraulic jump has been added, as well as additional data on natural streams and the measurement of flowing water. The entire text has been rewritten.

Heizung und Lüftung. By Johannes Körting. Walter de Gruyter & Co., Berlin, 1929. Cloth, 4 × 6 in., 2 vols., illus., tables. 1.50 r.m. each.

A brief review of the design and construction of heating and ventilating installations in dwellings. The subject is presented in simple language, in a manner suited to the needs of builders and owners.

Illustrated Technical Dictionaries in English, German, Russian, French, Italian, Spanish; Vol. 11, Electrical Engineering and Electrochemistry. Edited by Alfred Schlomann. Technische Wörterbücher-Verlag, Berlin, 1928. Distributors, V.D.I. Verlag. Cloth, 7 × 10 in., 1304 pp., illus. 80 mk.

Every translator of electrical literature owes a vote of thanks to the editor of this work, and to the Society of German Engineers,

which provided the funds for it. In its present form it is practically a new work, as it has been revised and reset, and greatly enlarged over the previous editions. Approximately 20,000 expressions common in electrical literature are given, with their meanings in the six principal European languages. In preparing the work, the editor has had the assistance of expert engineers in each country. Wherever possible, the meaning of an expression is clarified by a sketch, formula, or symbol.

The dictionary is indispensable to every translator or reader of foreign literature. It is by far the best available aid.

Der Indizierte Wirkungsgrad der Kompressorlosen Dieselmaschine. By Fritz Schmidt. (Forschungsarbeiten, heft 314.) V.D.I. Verlag, Berlin, 1929. Paper, 9 × 12 in., 22 pp., diagrams, tables. 4.50 r.m.

The investigation here reported was undertaken to make it possible to determine the indicated efficiency of Diesel engines more exactly and simply than has been the case in the past. The author subjects the customary methods to a critical study, and finally develops a method by which the indicated efficiency may be simply determined with the aid of certain tables and diagrams which he supplies.

Kompressorlose Dieselmotoren und Semidieselmotoren. By M. Seiliger. Julius Springer, Berlin, 1929. Bound, 7 × 10, 296 pp., illus., diagrams. 37.50 r.m.

This treatise discusses these types of engines theoretically and practically. The author presents a new theory of the internal-combustion engine, in which the working process is regarded as a function of the process of combustion, time, and cooling. The laws of the combustion process are investigated and applied to semi-Diesel and compressorless Diesel engines. The principal commercial types of engines are examined and practical conclusions drawn.

Die Maschinenelemente, vol. 2. By Felix Rötscher. Julius Springer, Berlin, 1929. Bound, 8 × 11 in., 1354 pp., illus, diagrams, tables. 48 r.m.

The final volume of an important treatise on machine design, publication of which began in 1927.

The book has been given great praise in Germany, both for its comprehensiveness and for its method. Its especial virtue is the attention paid to questions of manufacture and working conditions. While the mathematical and kinematical factors are fully considered, the author also gives full attention to such matters as the most economical methods of forming the elements of a machine, the selection of the best material, the conditions under which the machine will be used, and other factors that affect the efficiency of the finished product. The result is an unusually practical reference book for designers and manufacturers.

Neue Tabellen und Diagramme für Wasserdampf. By Richard Mollier. Sixth edition. Julius Springer, Berlin, 1929. Paper, 8 × 11 in., 28 pp., plates. 2.70 r.m.

This apparently is a revised issue of the fifth edition, published in 1927. The pressures covered now extend to 225 atmospheres.

Profession of Engineering; Essays. Edited by Dugald C. Jackson and W. Paul Jones. John Wiley & Sons, New York, 1929. Fabrikoid, 5 × 8 in., 124 pp. $1.50.

This collection of essays by noted engineers is designed primarily for the young man choosing a vocation. Starting with discussions of the education of the engineer and of the factors that make for success in engineering, various authors describe the main branches of the profession. The final essay, by President Hoover, is on the engineer's contribution to modern life.

The authors suggest the book as a text for freshman orientation courses and courses in engineering English, and as a guide to parents and others interested in the profession and the qualifications necessary for entering.

Steam, Air, and Gas Power. By William H. Severns and Howard E. Degler. John Wiley & Sons, New York, 1929. Cloth, 6 × 9 in., 425 pp., illus., tables, $4.

An elementary text on heat engineering, for courses of limited duration. It aims to describe briefly and clearly typical and representative equipment, and to explain the theory of such machines and devices. The mathematical calculations involved are of the simplest order.

Steam Turbines. By James Ambrose Moyer. Sixth edition. John Wiley & Sons, New York, 1929. Cloth, 6 × 9 in., 557 pp., illus., plates, diagrams, tables, $4.50.

In the new edition of this well-known text, special attention has been given to the calculations for the designing of steam turbines. New sections have been added upon the enlarged field of application of bleeder turbines, upon recent data on the variation of steam consumption with the age of turbines, upon various designs of packing, and upon new features in the design of large high-pressure turbines. An appendix contains the calculations for the design of a reaction steam turbine.

Strength of Materials. By Jasper Owen Draffin. John Wiley & Sons, New York, 1928. Cloth, 6 × 9 in., 275 pp., illus., portraits, diagrams, tables, $3.

This textbook aims to meet the needs of engineering students of the strength of materials, particularly architects, who have not studied the calculus. It includes the topics commonly taught in undergraduate courses, presented in a way that will enable the student to make a reasonable estimate of the resistance that a structural part will offer to loads, and to develop this estimate from the principles of equilibrium and a knowledge of materials.

Strength of Materials. By Alfred P. Poorman. Second edition. McGraw-Hill Book Co., New York, 1929. Cloth, 6 × 9 in., 343 pp., diagrams, tables, $3.

This textbook by a professor of applied mechanics at Purdue University is a companion to his "Applied Mechanics" and is intended for use by undergraduate students with a knowledge of physics, the calculus, and statics.

This new edition has additional matter on sudden and impact loads on beams, riveted joints, timber beams and columns, and on safe stresses for timber.

Theory of Heat Engines. By William Inchley. Third edition. Longmans, Green & Co., New York, 1929. Cloth, 6 × 9 in., 504 pp., diagrams. $5.

In order to have space for a complete exposition of both the thermodynamical and mechanical principles of the subject, all purely descriptive matter has been omitted from this book. It aims to give concisely a thorough course in the theory of heat engines, adapted to the courses given university students of engineering. The new edition has been edited by Dr. Arthur Morley, who has made various amendments and corrections.

Unbildsame Rohstoffe Keramischer Massen. By Rudolf Niederleuthner. Julius Springer, Berlin, 1928. Bound, 6 × 9 in., 577 pp., illus., diagrams, tables, 39 r.m.

While numerous books are extant upon the plastic materials of the ceramic industry, there has been no general description of the non-plastic materials available. Professor Niederleuthner has filled the gap with this book, which contains information hitherto accessible only in widely scattered places.

After a general discussion of the materials used to reduce plasticity, as fluxes and to increase refractory qualities, the various materials used for the last purpose are discussed, with special

attention to their physical and chemical properties. The book will be useful as a reference work to manufacturers generally.

Vibration Problems in Engineering. By S. Timoshenko. D. Van Nostrand Co., New York, 1928. Cloth, 6 × 9 in., 351 pp. $4.50.

An exposition of the fundamentals of the theory of vibrations with special reference to the application of the theory to such practical problems as the balancing of machines, the vibrations in turbines and in railroad track and bridges, and the whirling of rotating shafts. The topics discussed include harmonic and non-harmonic vibrations in systems with one degree of freedom, in systems with several degrees of freedom, and in elastic bodies. A chapter on measuring instruments is included. Applications to various engineering problems of importance are developed.

Voitures et Wagons. By J. Netter. J.-B. Baillière et fils, Paris, 1927. Paper, 6 × 9 in., 602 pp., illus., diagrams, 80 francs.

The greater portion of this book is devoted to passenger cars. The various elements—wheels, springs, draft gear, brakes, and bodies—are discussed at length, and chapters are given to heating and lighting. The descriptions are chiefly of French equipment, but a few types from other countries are included. Freight cars are discussed more briefly.

Vorlesungen über Differential-und Integralrechnung, vol. 2; Funktionen Mehrerer Veränderlicher. By R. Courant. Julius Springer, Berlin, 1929. Cloth, 6 × 9 in., 360 pp., 18.60 r.m.

The concluding volume of Professor Courant's textbook treats of functions with several variables. As in the first volume, his aim has been to present the principles and methods clearly and to emphasize their practical applications.

Wärme-und Kälteschutz in Wissenschaft und Praxis. Bound, 6 × 9 in., 186 pp., illus., tables. 16 r.m.

Die Grundlagen für den Vergleich von Wärmeschutzangeboten. Bound, 6 × 8 in., 63 pp., diagrams, tables. 7.60 r.m.

Die Technisch-Rechtliche Bedeutung von Garantien auf dem Gebiete des Wärme-und Kälteschutzes. Bound, 6 × 8 in., 62 pp. 6.50 r.m. Deutsche Prioform Werke Bohlander & Co., Köln-Rhein, 1928. For sale by Julius Springer, Berlin.

These three volumes issued by the Deutsche Prioform Werke contain technical data and advice to purchasers of heat-insulating materials based on the experience of that firm of manufacturers.

"Wärme- und Kälteschutz" is a general work on the principles and practice of heat insulation. The conduction of heat, the calculation of insulation, the testing of insulating materials, various methods of insulating, and the raw materials used are discussed. The book summarizes the data needed in designing and selecting materials and methods.

"Grundlagen für Vergleich der Wärmeschutzangeboten" aims to assist the buyer in comparing tenders from various firms. "Technisch-Rechtliche Bedeutung von Garantien" is a discussion of the technical and legal points of manufacturer's guaranties.

Wie Technik Dir im Haushalt Hilft. By C. Säuberlich. V.D.I. Verlag, Berlin, 1928. Paper, 6 × 8 in., 119 pp., illus., 4.80 r.m.

Explains the principles and construction of the technical appliances used in the household. Heating and ventilating apparatus, gas and electric cooling devices, washing and ironing machines, refrigerators, lamps, etc., are described in simple language.

A.S.M.E. 1929 Rochester Meeting Papers

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(2) Bausch, Carl L., Diamonds as Metal-Cutting Tools
(3) Bigelow, Carle M., Conservation of Lumber in Woodworking Plants
(4) Buckingham, Earle, Report on Thread Form of Milled Worms
(5) Candee, Allan H., Large Spiral Bevel and Hypoid Gears
(6) Conant, Wm. S., The British Apprenticeship Report and Its Value to American Industry
(7) Cushing, H. M., Evolution of Slag-Tap Furnaces at Charles R. Huntley Station, Buffalo, N. Y.
(8) Diederichs, H., and Pomeroy, W. D., The Occurrence and Elimination of Surge or Oscillating Pressures in Discharge Lines From Reciprocating Pumps
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A.S.M.E. Rochester Meeting Program

Rochester, N. Y., May 13-16, 1929

Monday, May 13

9:30 A.M. Council Meeting.

SYMPOSIUM ON BOILER-FURNACE REFRACTORIES, 9:30 A.M.

A Laboratory Slagging Test for Boiler-Furnace Refractories, R. K. HURSH.

A Study of Crystalline Compounds Formed in Slags and Boiler Furnace Refractories, T. A. KLINEFELTER and E. P. REXFORD.

A Study of Some Factors in Removal of Ash as Molten Slag From Powdered-Coal Furnaces, RALPH A. SHERMAN, P. NICHOLLS, and EDMUND TAYLOR.

Evolution of Slag-Tap Furnace at the Chas. R. Huntley Station, Buffalo, N. Y., H. M. CUSHING.

The Present Status of Tests for Refractories, S. M. PHELPS and J. S. MCDOWELL.

Proprietary Air-Cooled Refractory Walls, CHAS. S. GLADDEN.

SIMULTANEOUS SESSIONS, 2:30 P.M.

Education and Training

The Technical Institute—European Examples and Their Significance to American Education, WM. E. WICKENDEN.

Industry Specifies Its School-Training Needs, VIRGIL M. PALMER.

The British Apprenticeship Report and Its Value to American Industry, WM. S. CONANT.

Applied Mechanics (I)

The Calculation of Flywheels for Air Compressors, H. R. GOSS and H. V. PUTMAN.

Vibration Damping, Including the Case of Solid Friction, A. L. KIMBALL.

Boiler Feedwater Studies

Formation and Heat-Transfer Effects of Calcium Sulphate Boiler Scale, E. P. PARTRIDGE and A. H. WHITE.

Control of Boiler-Water Treatment to Prevent Embrittlement, FREDERICK G. STRAUB.

Evening

Informal Get-Together at home of MISS KATE GLEASON.

Tuesday, May 14

9:30 A.M. Council Meeting; Conference of Local Sections' Delegates.

SIMULTANEOUS SESSIONS, 9:30 A.M.

Machine-Shop Practice (I)

Economies Which May Be Effected in Power Transmission, W. W. NICHOLS.

Diamonds as Metal-Cutting Tools, CARL L. BAUSCH.

Report of an Investigation on Tungsten Carbide Cutting Alloys, W. PAUL EDDY, JR., and H. J. LONG.

Heat Transmission (Fuels Division)

Heat Insulation Practice in the Modern Steam Generating Plant, L. B. MCMILLAN.

Surface Transmission, R. H. HEILMAN.

Applied Mechanics (II)

Teaching of Advanced Mechanics in Universities, S. TIMOSHENKO.

Advanced Mechanics in the Electrical Industry, J. ORMONDROYD.

Wood Industries

Conservation of Lumber in Woodworking Plants, CARLE M. BIGELOW.

Manufacture of Fine Cabinet Work:
- Library and Office Furniture, D. J. MCLAUGHLIN.
- Upright and Grand Piano Cases, J. P. LINDSAY.

Afternoon

Excursions to Bausch & Lomb Optical Co. and Kodak Park Works, Eastman Kodak Co.

Evening

Dinner, Hotel Sagamore: Speaker, DR. C. E. KENNETH MEES, Director of Research Laboratory, Eastman Kodak Co.

Wednesday, May 15

SIMULTANEOUS SESSIONS, 9:30 A.M.

Machine-Shop Practice (II)

Progress Report on Thread Form of Milled Worms, EARLE BUCKINGHAM.

Large Spiral Bevel and Hypoid Gears, ALLAN H. CANDEE.

Materials Handling

Selective Package Conveyors, W. O. HILDRETH.

Handling Papers and Small Articles by Pneumatic Tubes, JAS. WHITING.

Economizers and Preheaters (Power Division)

Design and Proportions of Economizers and Air Preheaters, HOSEA WEBSTER.

Afternoon

Excursions: Gleason Works, The Todd Co., and Stromberg Carlson Telephone Manufacturing Co.

Evening

Illustrated Lecture: Ancient Roman Aqueducts and Other Engineering Works, PROF. C. L. DURHAM, Cornell University.

Thursday, May 16

SIMULTANEOUS SESSIONS, 9:30 A.M.

Management

Controlling the Manufacture of Parts on Order and for Stock by the Gantt Progress Chart, DAVID B. PORTER.

The Synchronization of Sales and Production, H. M. HUBBARD.

Mechanical Springs

New Type of Air Spring, J. K. WOOD.

Surges in Pump Discharge (Petroleum and Hydraulic Divisions)

The Concurrence and Elimination of Surge or Oscillating Pressures in Discharge Lines From Reciprocating Pumps, H. DIEDERICHS and W. D. POMEROY.

Equipment for Creep Tests (Research Committee on Effect of Temperatures of Metals)

Machine for Making Creep Tests at High Temperatures, G. D. BAGLEY.

Afternoon

Excursions: General Railway Signal Co., Taylor Instrument Companies, Hickey-Freeman, and Bastian Brothers.

Synopses of A.S.M.E. Rochester Meeting Papers

THESE papers, abstracts of which are being published on this and the following pages, are being printed in pamphlet form for the Rochester Meeting of A.S.M.E., Rochester, N. Y., May 13 to 16, 1925. They may be secured by filling out the blank on page 406 of this issue.

A Machine for Making Creep Tests at High Temperatures. By Glen D. Bagley. [Paper No. 1]

The demand for materials suitable for operation under stress at high temperature has made it necessary to investigate the properties of various alloys with regard to their resistance to creep. Various types of machines have been developed for this purpose. This paper describes the apparatus developed by the Union Carbide and Carbon Research Laboratories. Its principal features are a compound lever system of applying the load, similar to that used in regular tensile machines, and a simplified method of measuring the extension of the specimens. The compound lever system makes it possible to determine the load accurately and to use standard 0.505-in. diameter specimens without employing excessive weights, even at relatively low temperatures. The system used for measuring extension is such that the construction of the machine is simplified and the convenience of operation improved. The accuracy is ample for all creep tests except those in which extremely small creeps over long periods of time must be measured.

Diamonds as Metal-Cutting Tools. By C. L. Bausch. [Paper No. 2]

In this paper the author recites the history of the use of diamond tools in the plant of the Bausch & Lomb Optical Co., which he believes to be quite representative of the use of diamonds in general. Diamonds were first used in the turning of materials which were too hard for steel tools. Their next use was in obtaining high finishes on non-ferrous metals, and this was followed by their use on work requiring extreme accuracy. In all cases high speed was obtainable, although heavy cuts have never been possible with diamond tools. Data are given regarding the proper selection and setting of diamonds in relation to the cleavage plane of the material, as well as on cutting speeds and feeds, life of diamond tools, limitations due to vibration, etc.

Conservation of Lumber in Woodworking Plants. By Carle M. Bigelow. [Paper No. 3]

This paper gives particulars regarding a method for the installation of a differential group wage-payment plan for the cutting departments of woodworking plants. The group is paid in terms of the differential result between reduction in per cent wastage of lumber intake and board feet per man-hour production. The necessary details for accumulation of data for the installation of the method are given, the general method is completely described, and a summary of results of several typical installations given.

Thread Forms of Milled Worms. (Progress Report No. 3 of the A.S.M.E. Special Research Committee on Worm Gears.) By Earle Buckingham. [Paper No. 4]

This paper is a continuation of the material on helicoidal sections given in the author's paper on "Worm-Wheel Contact" presented before the Society in December, 1926. It covers the equations necessary to determine the thread form of milled and ground threads in various sections and also the sections of a helicoid formed by a straight-sided lathe tool, set toward the helix angle of a thread. This last helicoid is a convolute helicoid with the inclination of its generatrix in the opposite direction to that of the helix.

As an example the worm used in the drive AW-3 in Progress Report No. 2 of the A.S.M.E. Special Research Committee on Worm gears has been analyzed and the coordinates of the thread form in an axial section have been determined when the thread is produced by a lathe tool, a 4-in.-diameter thread milling cutter, a 12-in.-diameter grinding wheel, and by the flat side of a grinding wheel which would produce an involute helicoid.

This analysis shows that the form in the axial section of a thread produced by a lathe tool, tipped toward the helix angle, will be concave. That produced by a milling cutter may be concave, convex, or a form of double curvature, depending upon the diameter of the cutter, angle of thread, diameter and lead of screw, and depth of thread.

The curvature increases with a reduction in thread angle and an increase in helix angle. The milled forms become more convex with an increase in the diameter of the cutter or grinding wheel.

This paper is another attempt to introduce more mathematics in the machine shop to the end that we may know more definitely the conditions which we are contending with, and can therefore take the proper steps to meet them.

Large Spiral Bevel and Hypoid Gears. By Allan H. Candee. [Paper No. 5]

The paper deals with recent developments in the manufacture of large bevel and hypoid gears, the principal subjects being:

1 Large bevel gears of greatly improved running qualities due (*a*) to generating instead of planing the teeth, and (*b*) to the use of spiral teeth instead of straight teeth;

2 A new type of large bevel-gear-generating machine designed at the Gleason Works, with a description of the unique combination of mechanical movements used to produce spiral teeth;

3 The accurate generation of large hypoid gears in which the axis of the pinion is offset from the axis of the gear, thus making it possible for the two shafts to continue past each other.

The British Apprenticeship Report and its Value to American Industry. By William S. Conant. [Paper No. 6]

The Report discussed in this paper was compiled largely from questionnaire data obtained by the Ministry of Labour through the National Conference of Employers' Organizations. It is estimated that, in Great Britain and northern Ireland, of males under adult age employed in industries where apprenticeship or learnership occurs, about one-fifth are receiving some form of industrial training, which is reduced to one-seventh if the textile industry is included.

Unlike the usual practice in America, where apprenticeship training is more apt to be found in the larger works, in England a decrease is apparent in the number so trained.

Reference is made to the calculations used in the Report of the number of journeymen per apprentice in each trade which should maintain the existing number of journeymen in industry; also (within a single occupation) the ratio necessary to secure a given increase or decrease of journeymen in a year. The subject of training is treated at extended length, both shop and desk work. Other subjects treated very fully in each trade are the ratio of apprentices to skilled men, proportion of apprentices failing to complete their course, trade unions and apprenticeship, upgrading, wages and special schemes of apprenticeship.

The general conclusion of the Report is to emphasize the extreme value of apprenticeship in modern industry; to warn the larger firms to train their just proportion of apprentices; to urge manufacturers to change their method of selection of apprentices, giving greater attention to technical instruction and gradually increasing the ratio of apprentices to the total employed, so that skilled workers may continue to be available.

The fact that in Great Britain it has been found worth while to make a survey of apprenticeship is cited as reason for a similar investigation here on completion of the study of intensive types of technical education now under way.

Evolution of the Slag-Tap Furnace at the Charles R. Huntley Station, of the Buffalo General Electric Co. By H. M. Cushing, Buffalo, N. Y., [Paper No. 7]

The handling of low-fusion-ash coals at high ratings and with high efficiencies is one of the stiffest problems ever presented to a furnace designer. This paper tells how in their attempt to design

a furnace that would burn any coal offered on the Buffalo market the engineers developed the slag-tap furnace for burning powdered coal, after ten years' experience in driving stoker-fired boilers at 300 to 400 per cent of rating. Because of the greater freedom in selecting coals for a powdered-coal-fired furnace and on account of the greater capacities that could be obtained from the boilers by that method of firing, also because boilers so fired could be made to respond more readily to sudden changes in load incident to peak-load standby plant operation than by any other method of coal firing, powdered-coal firing was chosen for the 60,000-kw. 1926 extension to Charles R. Huntley station.

To obtain data for designing the furnaces under four cross-drum boilers which were purchased to deliver 200,000 lb. of steam per hour, an experimental furnace was installed under one of them. Maximum ratings were in mind and 275,000 lb. per hr. evaporation was obtained.

The paper shows how these experiments, on a furnace designed to remove the ash in the dry form, led to the development of the slag-tap furnaces for the 1926 extension and again for the 1928 extension, where the ratings were increased still further.

The performance of the slag-tap furnace has exceeded the expectation of its designers. Some of its advantages from both the design and operating standpoint are:

- It requires a minimum of building volume
- It will burn efficiently and at high ratings an unusually wide variety of coals
- It produces quick ignition of the fuel
- It prevents infiltration of air into the bottom of the furnace
- It requires a minimum of ash-handling labor, and
- The ash handling is remarkably free from dust and dirt.

THE OCCURRENCE AND ELIMINATION OF SURGE OR OSCILLATING PRESSURES IN DISCHARGE LINES FROM RECIPROCATING PUMPS. By H. Diederichs and W. D. Pomeroy. [Paper No. 8]

This paper deals first with the occurrence of surge or oscillating pressures in the field, in connection with the pumping of oil, resulting in some cases in serious damage. It next reports upon the experiments carried out at Seneca Falls in order to study the phenomenon while all the conditions of operation are under definite control. This is followed by a study of the theory which underlies the occurrence, and definite recommendations are given to eliminate it. It is pointed out that the means at hand for doing this are twofold: (a) The establishment of a proper relation between pump speed and length of discharge line, and (b) the use of air chambers. A diagram is given which shows the relation between length of line and the critical speed of duplex and triplex pumps, and the paper concludes with a discussion of air-chamber design and operation.

PROPRIETARY AIR-COOLED REFRACTORY WALLS. By C. S. Gladden. [Paper No. 10]

This paper discusses briefly the evolution of the boiler furnace, the increasing tendencies toward higher ratings of boiler operation and the attendant increasing maintenance troubles with refractories. It then describes some of the proprietary air-cooled walls now available for the consideration of designing engineers and boiler-plant operators, and relates the operating experiences of certain engineers with air-cooled refractory walls of different types. In conclusion the author gives his opinions concerning the conditions suitable for air-cooled refractory wall installations.

CALCULATION OF FLYWHEELS FOR AIR COMPRESSORS. By H. R. Goss and H. V. Putman. [Paper No. 11]

The authors present a short history of the application of low-speed synchronous motors direct connected to ammonia compressors. It is shown how the use of XY curves has brought about a practical solution of the flywheel problem and how in practically all present-day cases the necessary flywheel effect can be incorporated in the rotor of the synchronous motor. A short history of the application of synchronous motors to air compressors is also given and the special problems encountered due to the unbalanced weights of reciprocating parts and to part-load operation of air compressors are discussed.

A derivation of the fundamental differential equation of the XY curve is given and a simple method presented for its solution. An example illustrating the method of making XY curves is given. Curves and data are given which materially reduce the labor involved in making XY curves. A set of eight XY curves for two-cylinder double-acting two-stage air compressors is included. These curves cover full-load, no-load, and six different part-load conditions. A second set of two XY curves is presented covering full-load and no-load operation for single-cylinder double-acting single-stage compressors.

The paper has two appendixes. Appendix No. 1 presents formulas for calculating the theoretical indicated horsepower for single- or two-stage multi-cylinder compressors. Appendix No. 2 presents methods of calculation of the theoretical torque curves for compressors. An expression for the inertia torque due to the reciprocating parts of a compressor is given. Tables are presented giving the results of the harmonic analysis of the torque curves due to the gas forces at full load, half-load, and no load for the high-pressure and low-pressure cylinders. It is shown how these harmonics of the separate cylinders can be combined to give the harmonics in the torque of the complete machine when operating at full load or under part-load conditions.

SURFACE HEAT TRANSMISSION. By R. H. Heilman. [Paper No. 12]

In view of the dearth of reliable data on the emissivity coefficients of various surfaces at the lower temperatures met with in refrigeration and heat-insulation work, the author undertook an investigation of the subject at Mellon Institute of Industrial Research, Pittsburgh. The paper describes that investigation, and among other things gives particulars regarding the methods employed in determining surface coefficients; the radiometer used; the determination of emissivity coefficients; derivation of an equation for convection; convection losses from various geometrical shapes; total heat loss from various shapes and surfaces, etc. Several charts are included in the paper which make it possible for the engineer readily to determine the total heat loss from various surfaces, and which eliminate all need for calculations for surface temperatures up to 700 deg. fahr.

SELECTIVE PACKAGE CONVEYORS. By W. O. Hildreth. [Paper No. 13]

Severe competition is forcing every manufacturing industry to secure the most efficient layout of machinery and the maximum output from every square foot of floor space. Economical handling of materials, orders, letters, and instructions within the plant are important to secure the highest efficiency.

Conveyors of many types are now available, and "selective" conveyors are an important variety. These are adapted for automatically delivering packages or materials to various predetermined points selected by the sender at the time the material is dispatched.

The selection of destination may be determined by the size or weight of the package itself or by the position of a movable finger or selective pin. If the material to be transported is carried in trays or tote boxes over a conveyor system the movable selective finger can be mounted upon the upper front edge of the tray. This selective finger, for light service, may itself be used to deflect the tray from a conveyor by means of a switch bar, or may operate an electric circuit maker to control the movement of a heavy deflector bar.

The latest method of selection employs a separate pilot car carrying the selective pin and followed upon the conveyor belt by a string of boxes, cartons, or bags which are all going to the same destination. The procession is followed by a caboose car carrying a selective pin which releases the deflector bar after the caboose has passed and allows the deflector to swing out of the path of passing pilot cars until another car approaches with its selective pin in the proper position to operate this particular deflector.

SYNCHRONIZATION OF SALES AND PRODUCTION. By H. M. Hubbard. [Paper No. 14]

Since the early days of the United States, the author states, the fundamental economic factors governing American business and business methods have undergone a marked change. The era of exploitation of natural resources in a new country is past, and the emphasis has been shifted from production to marketing and the means for effecting the coordinating of the activities in these two important departments.

Our prosperity, both agricultural and industrial, depends to a large extent upon the ability to export surplus production. Severe competition has developed from both domestic and foreign products, and the rehabilitation of European industry will only serve to make the situation more acute. The persistence of a hand-to-mouth buying policy, and the development of the style factor, are other examples of the new economic era.

The American executive has realized that the methods of yesterday are unsuited to the problems of today, with the result that a new technique is being developed which visualizes business as a coordinated and well-balanced whole. In the majority of cases this coordination revolves about some kind of a budget. Operating schedules are based upon forecasts prepared by the sales department, which in turn presumably has made its plans upon careful market studies. It is thus possible to prepare a financial budget

well in advance of operations and to estimate the effectiveness of the proposed program.

The author gives some specific illustrations of the new method as applied in an organization producing a variety of products in scattered plants.

A Laboratory Slagging Test for Boiler-Furnace Refractories. By R. K. Hursh. [Paper No. 15]

This paper gives particulars of a simulative service test of refractories with coal-ash slag made in a laboratory furnace in which the test brick form the lining of a cylindrical chamber rotated about a vertical axis. Powdered slag or a mixture of slag with powdered coal is fed at a uniform rate through the gas burner which heats the furnace, impinging on the vertical faces of the brick and flowing out through the bottom of the furnace. Temperature and atmospheric conditions are controlled and the test brick receive equal slag treatment. Comparison of slag effect on the refractories is made by volume loss per unit area of exposed surface.

Tests have been made with slags representing coals used at five power stations where field tests were conducted, and the results are presented by the author. He finds that the relative effects of these different slags at a furnace temperature of 2900 deg. fahr. varies with the composition and fusibility of the coal ash. Further, the erosion of the refractory is dependent on the viscosity of the slag and increases in direct proportion to the furnace temperature. Tests made at temperatures corresponding to those in the boiler furnaces produce similar action on the refractories, as indicated by petrographic examinations. The relative resistance of refractories of different composition and physical structure is not the same for different slags.

Vibration Damping, Including the Case of Solid Friction. By A. L. Kimball. [Paper No. 16]

The idea of logarithmic vibration decrement is briefly reviewed and several ways of expressing it and finding it are given.

The simple case of a vibrating reed is treated, three kinds of damping being considered—(1) an external liquid damping, (2) a liquid viscosity damping within the spring, and (3) solid damping within the spring whereby the dissipation per cycle is independent of frequency but depends upon amplitude squared. These cases are discussed both for free vibrations and sustained vibrations.

A method is given for analyzing solid damping vibration problems which is of general application to all cases of vibration which can be treated on the assumption of an ideal viscosity damping. This method is used by Ormondroyd and Den Hartog in the closure to the discussion of their paper entitled "The Theory of the Dynamic Vibration Absorber." [Trans. A.S.M.E., vol. 50 (1928).]

The discussion of vibration damping given in the paper presents methods used by the author for several years past in vibration work.

A Study of Crystalline Compounds Formed in Slags on Boiler-Furnace Refractories. By T. A. Klinefelter and E. P. Rexford. [Paper No. 17]

For several years the action of boiler-furnace refractories under various service conditions has been investigated. The present method of investigation used by the Bureau of Standards at Columbus, is similar to that used by the Geophysical Laboratory in studying the lime-alumina-silica system, with the addition of iron. It is known as the quenching method. The apparatus consists of two furnaces, a preheater and a quenching furnace automatically controlled. The length of time required for each melt depends on its composition. Each melt determines an equilibrium point, a number of which are necessary for determining the point sought, i.e., the temperature at which the primary phase for that composition disappears and the charge becomes a clear glass. A number of the latter points determine a surface known as an "isopleth." In working out the system one component is varied, in this case iron, and the others held constant. In conjunction with the above, field slags, the data of which are known, are being quenched and their results compared with those of the component system.

The paper is a progress report of the work done to date, of the methods used, and of the difficulties encountered in a laboratory study of the equilibrium relation of oxides composing the slags on boiler-furnace refractories at high temperatures. No data or conclusions are presented.

Heat-Insulation Practice in the Modern Steam-Generating Plant. By L. B. McMillan. [Paper No. 18]

This paper outlines briefly the engineering principles of heat-insulation design. Especial emphasis is given to the fact that the heat dissipated by so-called "radiation" losses is from the most valuable portion of the heat, and that these losses frequently result in the lowering of heat potential or temperature head, with a resulting loss in the value of all of the heat as measured by its remaining effectiveness.

A distinction is drawn between the cost of average heat and the value of a particular portion of the heat in terms of what it will accomplish in the way of useful results. The higher value of high-potential heat is demonstrated, and a specific evaluation in the case of heat in superheated steam used for power generation shows that the high-potential increments of such heat may be $1^1/_2$ or even 2 times as valuable as the average heat content of the steam.

Results accomplished by the insulation of various units of power-plant equipment are discussed, and typical installations are shown.

The factors involved in determining the most economical thickness of insulation are discussed, and a chart is given on which each of the factors may be taken separately into account. The resulting economical thickness may be quickly and conveniently determined directly from the chart.

Economies Which May Be Effected in Power Transmission. By W. W. Nichols. [Paper No. 19]

From an economical standpoint of maintenance, power-transmission equipment is not given careful consideration by management. It should not be left to the supervision of some old-time millwright. Belting is not given a close enough inspection upon its receipt to determine if it meets all the requirements laid down by the specifications for its purchase. Many machines upon production work are over-belted, and little attention is given to the correct determination of the size of belt necessary for the work. Heavier belts could be installed profitably. By this means unnecessary wear and tear upon countershaft clutches would be eliminated. More attention should be given to the application of the correct size of motor to individually motor-driven machine tools. Great loss and low power factor result from the methods now pursued. The question of group driving and the economies effected thereby are deserving of being more closely considered and of having their cost compared with individually motor-driven tools, both from an initial standpoint and a maintenance standpoint.

Advanced Mechanics in the Electrical Industry. By J. Ormondroyd. [Paper No. 20]

Modern mechanical engineering problems have become so complicated that fundamental analysis is required for their solution. The usual mechanical engineering graduate is not completely prepared to undertake such analysis. The Westinghouse Company conducts a design school in which the young mechanical engineer becomes familiar with the analytical aspect of his profession. The paper outlines the work done in this school.

Industry Specifies Its School-Training Needs. By Virgil M. Palmer. [Paper No. 21]

This paper describes a cooperative educational experiment being carried on by the industries of Rochester, N. Y., and the Rochester Mechanics Institute. From a survey conducted it was found that while educational requirements for major executives and for industrial common labor are now fairly well covered by educational institutions, there is an important intermediate field in which are the junior line and staff executives, which as yet has not been adequately covered.

Specifications expressed in terms of the qualities desired in the Institute's graduates were formulated, together with detail recommendations covering training method and course content, which in the judgment of Rochester industries would best meet these specifications.

The Formation and Thermal Effects of Calcium Sulphate Boiler Scale. By Everett P. Partridge and Alfred H. White. [Paper No. 22]

A fundamental study of the manner in which calcium sulphate scale forms upon an evaporative surface, a redetermination of the solubility values for calcium sulphate in the boiler temperature range, and measurements of the rate of formation and heat conductivity of calcium sulphate scales produced in an experimental boiler, are described in abstract in this paper.

Evidence is presented to show that the initial deposition of calcium sulphate scale takes place as the result of the evolution of bubbles, either of dissolved gas or of steam, from an evaporative surface, and that the continued growth of scale is dependent upon the fact that the solubility of calcium sulphate decreases with temperature increase. The work of the authors thus presents a new explanation of the mechanism of initial scale formation, supports Hall's theory

of the growth of scale, negates the colloidal theory of scale formation, and offers a fundamental basis for the study of scale-prevention methods. Photomicrographs of the early stages of deposition and growth of calcium sulphate scale are shown, as well as photomicrographs of scales produced under varying conditions.

From the results of their own work and from that of other investigators, the authors present a discussion of the present knowledge concerning calcium sulphate scale. While the effect of scale upon heat utilization in modern boilers is believed to be very slight, calculations based on the heat conductivity of anhydrite scale indicate the importance of preventing overheating of tubes due to the insulating effect of scale deposits within them.

PRESENT STATUS OF TESTS FOR REFRACTORIES. By Stuart M. Phelps and J. Spotts McDowell. [Paper No. 23]

Tests for refractories may be divided into three general types: durability, suitability, and control. Durability tests can be made only in industrial furnaces, under actual operating conditions. Suitability tests may be carried out in the laboratory, under conditions which simulate those of service as closely as possible. Control tests, for maintenance of uniformity of product, should be relatively simple and require only a short length of time to perform. The pyrometric-cone equivalent gives an index of refractories, but is not a measure of the actual temperature which a material will withstand under long-continued heating. The standard load test is not an index of refractoriness, but is a good control test, especially for brick to be used under load at high temperatures. Difficulties of interpretation affect the value of reheat and spalling tests. The most useful specifications are those of the control type.

CONTROLLING THE MANUFACTURE OF PARTS ON ORDER AND FOR STOCK BY THE GANTT PROGRESS CHART. By David B. Porter. [Paper No. 24]

This paper deals with two special applications of the Gantt progress chart in controlling production. The first shows the plan for the manufacture and assembly of parts on an order, and the progress of work in accordance with the plan. The arrangement of parts on this chart follows the natural order in the assembly of the product. The proper relationship of parts to each other and to the whole is made visible by a system of marginal indentations. This makes it possible to show by one line for each part the amount of stock on hand and in process, and the amount of time ahead or behind schedule. It also shows the time of starting work on each operation without the use of additional bars, thus condensing the chart.

The second chart is constructed essentially like the first one, but is designed for the case where manufacturing for stock is already in progress; that is, parts are being made both continuously and intermittently for continuous assembly at a uniform rate. This chart is designed to show the current conditions of stores and parts in process and the amount of time behind or ahead of schedule for each part and assembly. The method for laying out the chart is fully explained.

The function of such charts is to bring in advance to the attention of the executive those things which require action, and thereby eliminate the necessity of following up after delays have occurred. The charts measure the progress made on the manufacturing program, and in so doing they also serve as measures of executive ability.

A STUDY OF SOME FACTORS IN REMOVAL OF ASH AS MOLTEN SLAG FROM POWDERED-COAL FURNACES. By Ralph A. Sherman, P. Nicholls, and Edmund Taylor. [Paper No. 25]

The purpose of this investigation, which was conducted at the Toronto, Ohio, station of the Pennsylvania-Ohio Power and Light Co. in cooperation with Stevens & Wood, Inc., New York, was to study those factors governing the application of the slagging method of ash removal which are related to the characteristics of the ash of the coal burned. The history of the development of the merits of slagging furnaces is briefly discussed and the results of observations made when burning three coals, whose ash had fluid temperatures of 2400, 2600, 2800 deg. fahr., in a furnace fired with horizontal burners and having bare water tubes set on three walls, are presented. The following studies were made: (1) The condition of the slag in the hearth and on tapping: (2) the temperature of the slag; (3) the temperature and composition of the gases near the slag bed; (4) the relation of the composition and fusion temperatures of the slag and the dust carried out of the furnace to those of the original ash; (5) the percentage of the ash fired which was carried out of the furnace and stack; (6) the relative temperatures of the gas entering the boiler tubes in two furnaces, one with a lower water-tube slag screen and the other with a slagging bottom; and (7) a brief study of the amount of flux necessary to add to a given ash to obtain a fluid slag.

CONTROL OF BOILER-WATER TREATMENT TO PREVENT EMBRITTLEMENT. By Frederick G. Straub. [Paper No. 26]

There is much interest in the question of methods of water treatment to prevent the cracking of boilers, commonly described as embrittlement. The author discusses the necessity for boiler-room control of the treatments used to prevent embrittlement. This control is based upon rapid and sufficiently accurate analyses, which may be run readily by the boiler attendants. The analyses discussed are for total alkalinity, sodium sulphate, and phosphate. A detailed description of a calorimetric method for phosphate is given. The article recommends that all boiler-water analyses be checked from time to time by laboratories familiar with water analysis.

THE TEACHING OF ADVANCED MECHANICS IN ENGINEERING SCHOOLS. By S. Timoshenko. [Paper No. 27]

The modern tendency in industry is to make more and more use of scientific methods in solving engineering problems. For this purpose properly trained men are needed. The leading industries, feeling the need for men of this type and not being able to find them among the university graduates, have begun to give such training themselves. The mechanical design school conducted by the Westinghouse Company is an example of this. In that school some ten carefully chosen recent graduates receive a six months' course in the advanced subjects of elasticity, dynamics, etc., with applications to actual live problems.

It is clear, however, that the natural place for such an education is the university, and the teaching of mechanics there should be brought up to the level of that of physics and chemistry. The S.P.E.E. and the A.S.M.E. have both recognized the movement: the first in its summer sessions for engineering teachers, and the second in its recent creation of a division for Applied Mechanics.

DESIGN AND PROPORTIONS OF ECONOMIZERS AND AIR PREHEATERS. By Hosea Webster. [Paper No. 28]

Thirty years ago 200 lb. working pressure and 40 lb. of coal burned per square foot of grate surface were the maximum. Superheat had not come into use. Since that time there has been a rapid development or evolution in the design of steam-generating and fuel-burning equipment. Today the rate of evaporation per square foot of boiler heating surfaces and the rate of fuel burning per foot width of furnace have increased 1000 per cent, and 1400 lb. steam pressure and 800 deg. steam temperature have passed the experimental stage, with indications that both pressures and temperatures may go higher where conditions of service and of fuel cost warrant. Modern high pressures and temperatures and high rates of fuel combustion have not only required much greater care in the selection, fabrication, design, and construction of pressure parts and furnaces and fuel-burning equipment, but also an entire rearrangement and distribution of heat-absorbing equipment. The temperature of the gases leaving the stack is an approximate measure of the overall efficiency. Recovery of the heat contained or carried in the gases leaving the steam generator proper may be accomplished by an economizer or an air preheater or both. Vertical cast-iron economizers decidedly antedate the increase in working pressures which required the use of steel tubes, which now are mostly horizontal and of the return-bend type, and because of the greater susceptibility to interior corrosion, may be fed only by water practically oxygen free. The introduction of pulverized coal requiring preheated air for proper combustion has greatly extended the use of air preheaters, of which three types are in use: tubular, plate, and regenerative. While the additional efficiency of a generating equipment runs from 3 to—in some cases—7 per cent with economizers, it runs from 5 to 10 and sometimes more where air preheaters are used. Service and operating conditions may warrant the use of either or both, each plant being an individual problem of station economics.

HANDLING PAPERS AND SMALL ARTICLES BY PNEUMATIC TUBES. By James Whiting. [Paper No. 29]

Pneumatic tubes as applied to the handling of papers and small articles accomplish what the telephone does for the spoken word. They not only now move the mass of paper work attendant on our industrial activity, with its intensive distribution, keen competition, and large production, but are being applied continuously to the mechanical processes of production.

Applications of pneumatic tubes comprise $1^1/_4$-in.-diameter tubes handling radio messages, telegrams, telephone toll tickets, etc.; $2^1/_4$-in. tubes for general message and utility service; 3-in. tubes for

handling tools, small machine parts, samples, etc.; 4-in. tubes handling hot ingot test pieces, gunpowder, paint samples, etc.; 5-in. tubes in testing laboratories and railroad freight yards; 3-in. × 6-in. oval tubes for bank service in handling pass books and deposits, and in publishing houses for carrying copy and proofs, etc., and 4-in. × 7-in. oval tubes handling complete folios of correspondence, insurance policies, etc.

The tasks to which pneumatic tubes are applied are innumerable and form a list which includes every industry, and as added applications are made in the general business world, other new applications become constantly apparent.

THE TECHNICAL INSTITUTE—EUROPEAN EXAMPLES AND THEIR SIGNIFICANCE FOR AMERICAN EDUCATION. By W. E. Wickenden. [Paper No. 30]

The term "technical institute" is the best common designation for schools of a non-university type which work on an age level above the secondary schools. There are admirable examples in the more carefully planned European systems for which we have few counterparts. They are not trade schools nor are they preparatory schools for higher studies, but are intended for young men already oriented to industry who wish intensive preparation for definite lines of advancement. In addition to engineering courses of a fairly general, though practical, character, these schools provide nearly all the higher training in the technology of specific industries and training for particular technical functions.

Examples are cited from the higher schools of mechanic arts in France, which train definitely for the supervision of industrial production; from the local technical institutions of Great Britain, which form the apex of each local unit of the educational system and give the higher forms of continuative education for men employed in industry; and from the higher schools for machine construction, building construction, and specific industries in Germany, which accept students only after a considerable period of industrial experience.

In conclusion, the author favors the policy of recruiting a much larger proportion of our higher technical personnel from men who have already had normal industrial experience. For that purpose there is need of a second and more flexible ladder parallel to the university system, to which agency we may look to train men for the supervision of industrial production, installation, and operation, and to train in the operative technology of specific industries. The major responsibility for filling the present gap appears to rest upon the states and the larger industrial cities, with the national organizations of the engineering profession exercising a role of guidance in the absence of any national ministry of education.

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AIR COMPRESSORS

Portable. Demag Motor-Compressors. Demag News (Duisburg), vol. 3, no. 1, Jan. 1929, pp. 24–25, 5 figs. Details of portable compressed-air generating plants; carriage portion designed to be trailed by truck; speed 19.5 m.p.h.; plant is combination of engine and compressor assembled on joint crank housing; two cylinders facing flywheel constitute engine, while those on ventilator side belong to compressor; engine retains power reserve of 15 per cent.

Regulation. Electropneumatic Regulation of Compressors (Elektropneumatische Kompressor-Regelung), Immerschitt. Waerme (Berlin), vol. 52, no. 3, Jan. 19, 1929, pp. 36–38. Limits of efficiency of piston and turbo-compressors and behavior of these compressors under control are discussed; piston compressors with gas-engine drive; method of regulating piston compressors; description of 10,000-cu. m. piston compressor with 3-phase motor drive and electropneumatic control.

AIRPLANE ENGINES

Cowling. Recent N.A.C.A. Cowling Developments, F. E. Weick. Aviation, vol. 26, no. 7, Feb. 16, 1929 (Aeronautical Eng. Sec.), pp. 24–27, 7 figs. Tests made on open-cockpit fuselage and on engine nacelles both with new complete cowling, conventional cowlings, and various types of individual cylinder cowling; agreement between flight and wind-tunnel tests; project for Army and Navy of fitting two airplanes with new complete cowling and testing undertaken application of complete cowling to other engines; new cowling on Berliner monoplane.

Drag Testing. The Drag of a J-5 Radial Air-Cooled Engine, F. E. Weick. Popular Aviation and Aeronautics, vol. 4, no. 2, Feb. 1929, pp. 40 and 42, 4 figs. Brief description of tests of drag due to Wright Whirlwind engine mounted on cabin-type plane, made in 20-ft. propeller research tunnel of National Advisory Committee; drag measured for three exhaust systems at 60 to 100 m.p.h.; drag also measured throughout same range with engine removed and nose rounded.

Noran. Bat Aircraft Engine. Airway Age, vol. 10, no. 3, Mar. 1929, p. 348, 1 fig. Details of 3-cylinder radial airplane engine made by Noran Aircraft Co., San Francisco; weight is less than 97 lb., with hub and propeller: $3^7/_{16}$-in. bore; $4^1/_8$-in. stroke; 30 hp. developed at 1800 r.p.m.

AIRPLANES

Catapults for. The Design of Aircraft for Catapult Use, L. Harrison. Aviation, vol. 26, no. 7, Feb. 16, 1929 (Aeronautical Eng. Sec.), pp. 30–32. Typical modern catapult consists of track and supporting structure, engine, car moving on track, and devices to hold car; structural design of catapult and car; specification of design loads for catapult condition; three important conditions for design for which aircraft structure must be checked; actual stress analysis for calculation of loads on principal members of airplane.

Frames, Stresses in. Experimental Determination of Stresses in Airplane Frames (Sur la détermination experimentale des tensions dans les charpentes des avions), W. Margoulis. Académie des Sciences—Comptes Rendus (Paris), vol. 188, no. 4, Jan. 21, 1929, pp. 305–307. Results of study of stresses in fuselage of pursuit plane made with aid of Mesnager photoelastic (interference) apparatus.

Gliding. Gliding as a Sport, R. B. Evans. Aviation, vol. 26, no. 8, Feb. 23, 1929, pp. 562–565, 8 figs. Information regarding gliding activities here and abroad, type of equipment used, and future possibilities; $500 school glider marketed by Detroit firm; ground requirements; essential elements in soaring; launching glider with shock cord; intermediate school soarer known as Proefling; courses at Wasserkuppe school; gliding as national sport in Germany; National Glider Association described.

Helioplanes. "Helioplane," Developed by Resident of New Westminster, B.C., F. H. Fullerton. Can. Aviation, vol. 2, no. 2, Feb. 1929, p. 20. Few details of new plane designed by J. E. Hess which rises vertically from ground and can be brought down safely on roof or middle of city street; principles of helicopter and airplane combined; stabilizing fin makes it virtually foolproof while in air; it can be brought to earth with designated 30-ft. space from any height; tremendous lifting power; horizontal rudders control flight.

Joints, Welded. Testing Welded Joints for Aircraft Structures, H. L. Whittemore. Airway Age, vol. 10, no. 2, Feb. 1929, pp. 161–163, 5 figs. Series of tests of strength of all types of welded joints in steel tubing now used in airplanes; tests of T-joints and lattice joints; preparation of very carefully worked out procedure for welding specimens using oxyacetylene blowpipes. Abstract of introduction to presentation of report on General Procedure Control for Gas and Arc Welding Aircraft Joints for Experimental Program of U. S. Bureau of Standards, presented before Am. Welding Soc.

Noran Monoplane. Bat Monoplane for Sport Use. Airway Age, vol. 10, no. 3, Mar. 1929, pp. 348 and 350, 1 fig. See also West Flying, vol. 5, no. 3, Mar. 1929, p. 62. Details of high-wing monoplane built in two models by Noran Aircraft Co., San Francisco; Model P1 is one-plane plane and Model P2 will carry two passengers; full cantilever-type wing with flying wires is used with full length solid spruce spars and Finch modified Clarke Y rib; with special Bat engine 90-m.p.h. top speed is attained; landing speed 28 m.p.h.; wing span 24 ft.

Performance Calculation. A New Method for the Prediction of Airplane Performance, E. P. Lesley and E. G. Reid. Nat. Advisory Committee for Aeronautics—Tech. Notes, no. 302, Feb. 1929, 25 pp., 6 figs. New method for prediction of airplane performance in level and climbing flight, together with complete information regarding propeller speeds, is described; developed from Bairstow's system and making use of American absolute coefficients, this method has advantages of simplicity and brevity.

Performance Testing. The Reduction of Observed Airplane Performance to Standard Conditions, W. S. Diehl. Nat. Advisory Committee for Aeronautics—Report no. 297, 27 pp., 25 figs. Report shows how actual performance of airplane varies with air temperature when pressure is held constant; comparatively simple methods of reducing observed data to standard conditions; new methods, considered exact for all practical purposes, used by Navy Department for about a year, with very satisfactory results; brief historical review of important papers which have been published on subject of performance reduction; development of standard atmosphere.

Streamline. The Streamline Aeroplane, M. Jones. Flight (Lond.), vol. 21, no. 5, Jan. 31, 1929 (Aircraft Engr.), pp. 6–8. Discussion of how much power is wasted by designing machines producing non-streamline flow; description of ideally streamlined airplane; drag of real airplane exceeded sum of induced drag and skin-friction drag by amount which was measure of defective streamlining; estimating induced drag and skin frictions; if large commercial airplanes were ideally streamlined they would travel 60 m.p.h. faster for same power. Abstract of paper read before Roy. Aeronautical Soc.

Testing. "Over the Hump," A. M. Jacobs. Popular Aviation and Aeronautics, vol. 4, no. 2, Feb. 1929, pp. 15–18 and 97, 5 figs. Description of experiments conducted by Army at Wright Field; experiments in 5-ft. wind tunnel; testing materials; static tests of airplane parts; dy-

NOTE.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

namic tests of landing gears, wheels, axles, tail skids; throughout these tests, Army engineers worked in closest cooperation with manufacturer, suggesting, planning, and inventing, to get things they both wanted; engine testing.

Wings, Aileron Design. Effect of Variation of Chord and Span of Ailerons on Rolling and Yawing Moments in Level Flight, R. H. Heald and D. H. Strother. Nat. Advisory Committee for Aeronautics—Report, no. 298, 1929, 19 pp., 27 figs. Rolling and yawing moments due to ailerons of various chords and spans on Clark-Y and U.S.A.-27 wing sections studied; effect of scale on rolling and yawing moments; effect of slightly rounding wing tips; results apply to level flight with wing chord set at plus 4-deg. angle of attack and to zero pitch, yaw, and roll; work conducted in 10-ft. Bureau of Standards wind tunnel. Bibliography.

Wings, Multi-Spar. Multi-Spar Wing Design and Analysis, G. W. Debell. Aviation, vol. 26, no. 7, Feb. 16, 1929 (Aeronautical Eng. Sec.), pp. 18–23, 9 figs. Practical limits of application of multi-spar construction which is primarily adapted to cantilever wings; German method of multi-spar wings analysis; Burgess rational method of distribution; method which takes into account center of pressure movement although skin in metal-covered construction is still assumed to take drag forces; drag truss substituted in fabric-covered construction; arbitrary method of arriving at sizes of drag truss members.

Wings, Variable-Area. Variable Area Wing Developed for Airplane. Automobile Industries, vol. 60, no. 10, Mar. 9, 1929, p. 406, 1 fig. Description of tests of variable wing area installed on PA-3 plane, which has developed by H. D. Fowler to make safe takeoffs and landings possible; table shows comparative performance.

AIRPORTS

Planning. Airport Development in the United States, G. E. Crosby. Pub. Works, vol. 60, no. 3, Mar. 1929, pp. 91–94, 4 figs. Factors involved in selection of site and design of airport; area, accessibility to city, topography, flying conditions, parking facilities, runways, hangars and other buildings; design for airport of Newark, N. J., and for Mid-south airport, South Carolina.

ALLOY STEELS

Cutting Qualities. Cutting Qualities of an Alloy Steel as Influenced by Its Heat Treatment, O. W. Boston and M. N. Landis. Am. Soc. Steel Treating—Trans., vol. 15, no. 3, Mar. 1929, pp. 451–467 and (discussion) 467–473, 39 figs. Estimating machinability rating of S.A.E. 6140 steel under various heat treatments; cutting rating as influenced by tool life and finish secured; torque and thrust of $^3/_4$-in. drill as measured on drill dynamometer; time of $^1/_4$-in. drill to penetrate $^1/_4$ in.; pure annealing does not give best machining qualities; steels cut best when spheroidizing is greatest.

Machining. Machining Qualities of Alloy Steels, H. Mayersberg. Mech. World (Manchester), vol. 85, no. 2197, Feb. 8, 1929, p. 122. Results of tests comparing machining qualities of six specimens of alloy steel; determination of life of tool from relationship between speed of cut and volume cut away differs when machining steels of equal tensile strength but of different composition. Translated from Werkzeug.

Aluminum. See ALUMINUM ALLOYS.

Anti-Corrosive. Some New Developments in Acid-resistant Alloys, B. E. Field. Am. Inst. Min. and Met. Engrs.—Tech. Pub., no. 191, Mar. 1929, 12 pp., 11 figs. Paper describes part of investigation work on binary and ternary nickel alloys; nickel-molybdenum alloys have been found to possess resistance to hydrochloric acid, and fairly complete series containing molybdenum up to eutectic 49 per cent was studied; data on physical properties of nickel-molybdenum-iron and nickel-silicon-copper-aluminum alloys.

Brass. See BRASS.

Copper. See COPPER ALLOYS.

Magnesium. See MAGNESIUM ALLOYS.

ALUMINUM

Machining. Tools and Methods for Machining Aluminum, R. L. Templin. Machy. (N.Y.), vol. 36, no. 7, Mar. 1929, pp. 557–559, 4 figs. Detailed directions for making tools for turning, facing, planing and milling aluminum; cutting lubricants or coolants for machining aluminum; keen cutting edges important on cutting tools.

Properties. Tests of Effects of Melting, Rolling, and Heat Treatment on Properties of Aluminum (Untersuchungen ueber den Einfluss des Umschmelzens sowie des Walz und Gluehprozesses auf Aluminum), E. Maass and W. Wiederholt. Korrosion und Metallschutz (Berlin), vol. 4, no. 12, Dec. 1928, pp. 272–277. Report from division of metal chemistry and metal production of German Government Institute of Engineering Chemistry; effect of rolling and heat treatment on chemical properties, specific gravity, hardness, cupping quality, resistance to chemical corrosion etc.

ALUMINUM ALLOYS

High-Temperature Effects. Temperatures Affect Aluminum Alloys, R. L. Templin and C. Braglio. Foundry, vol. 57, no. 3, Feb. 1, 1929, pp. 117–120, 9 figs. Results of investigation of effect of short-time high-temperature tests of 10 different aluminum casting alloys and pure cast aluminum, specimens were sand cast and include more common commercial casting alloys of aluminum. Abstract of paper presented before Am. Soc. Mech. Engrs.

Sheet. Hot and Cold Forming of Aluminum-Alloy Sheet, R. J. Anderson. Metal Stampings, vol. 2, no. 2, Feb. 1929, pp. 125–128. Discussion of various aluminum-alloys used in practice, and their cold and hot pressing, stamping and other forms of commercial manipulation.

AMMONIA CONDENSERS

Heat Transmission. Heat Transfer in a Multitube-Multipass Ammonia Condenser, A. P. Kratz, H. J. Macintire and R. E. Gould. Refrig. Eng., vol. 17, no. 3, Mar. 1929, pp. 79–86 and (discussion) 86–89, 9 figs. Data presented were obtained incidental to investigations of heat transfer in ammonia condensers conducted by Engineering Experiment Station of University of Illinois; equations for heat flow through resistances in series; effect of water velocity; resistance of ammonia film; equations for resistance of water film; resistance of scale.

ASH HANDLING

Systems. Ash Disposal in Large Boiler Plants (Aschebeseitigung in Grosskesselanlagen), Schulte. Waerme (Berlin.), vol. 52, no. 4, Jan. 26, 1929, pp. 90–96, 9 figs. Notes on ash precipitation in furnaces and flues with burning of different kinds of fuels; manual disposal in small plants; technical improvements; requirements of mechanical handing; automatic-mechanical, pneumatic, and hydraulic ash-disposal systems; operating costs.

AUTOMOBILE ENGINES

Carburetors. European Engine Designs Bring Special Carburetor Problems, O. Jayes. Automotive Industries, vol. 60, no. 9, Mar. 2, 1929, pp. 362–368, 14 figs. Carburetor problems of European and American automobile engines are compared; British trend is toward manifolds of simplest possible contour; small power plants designed for high performance are usually equipped with dual carburetors; heating methods; importance of valve timing; auxiliary blower is possible development.

Combustion Chambers. Engine Compression Pressure Affects Thermal Efficiency, Detonation and Roughness, R. N. Janeway. Automotive Industries, vol. 60, no. 10, Mar. 9, 1929, 408–410 and 419, 6 figs. Effectiveness of combustion depends upon uniformity of mixture and rapidity of flame travel; latter factor is antagonistic to smoothness of operation; correctives for high-speed miss; controlling detonating tendency; advantage of aluminum piston not always fully realized; maximum smoothness consistent with high efficiency results from uniform acceleration up to maximum rate of pressure rise. Abstract of paper presented before Soc. Automotive Engrs.

Crankshafts, Machining. Design Influences Machining Operations on Automotive Crankshafts, F. B. Jacobs. Abrasive Industry, vol. 10, no. 3, Mar. 1929, pp. 95–96, 3 figs. Crankshaft grinding operations carried out in plant of Atlas Mfg. Co., Fostoria, Ohio, are described; work carried out on high-production basis by using machines of special design and abrasive wheels provided especially for this work; testing crankshafts.

Lubrication. Modern Problems of Engine Lubrication, L. H. Pomeroy. Automobile Engr. (Lond.), vol. 19, no. 251, Feb. 1929, pp. 70–74, 2 figs. Practical problems arising in lubrication of modern gasoline engines, particularly those relating to forced lubrication and use of aluminum pistons; lubrication when starting from cold; lubrication when under conditions of high speed and heavy loading; description of research made in experimental department of Pierce-Arrow Co. which threw considerable light on what happened to gasoline consumption of car when used intermittently for short distances in cold weather.

Pistons. New Compensating Piston Supported at Top by Ring and Invar Bar. Automotive Industries, vol. 60, no. 10, Mar. 8, 1929, pp. 418–419, 1 fig. Details of aluminum alloy piston with special provisions to compensate for difference in thermal expansion of aluminum and cast iron, and for differences in temperature reached in service by different parts of piston; piston produced by Sterling Products Corp., St. Louis; feature intended to eliminate looseness and consequent piston slap at low engine temperatures; control member also prevents "cocking" in cylinder; table of recommended practice for Sterling three-ring pistons.

Pistons. Automobile Engr. (Lond.), vol. 19, no. 251, Feb. 1929, p. 41. Troubles experienced with automobile-engine pistons of recent design are discussed; aluminum pistons still far from satisfactory, curious individual characteristics and anomalies are evidenced; plug position in relation to prevailing gas flow, is important factor in oil immunity; importance of prevailing induction temperatures and conditions.

Starters. Electric Motor-Car Startors, R. L. Smith-Rose and R. S. J. Spilsbury. Elec. Rev. (Lond.), vol. 104, no. 2672, Feb. 8, 1929, pp. 258–259. Duddell oscillograph investigation of battery voltage and operating current of electric motors ordinarily used for starting motor-car engines. Paper presented before Instn. Elec. Engrs.

AUTOMOBILE PLANTS

Budgets. How Stutz Budgets Its Activities Almost to the Day and Dollar, L. A. Baron. Automotive Industries, vol. 60, no. 9, Mar. 2, 1929, pp. 372–375, 2 figs. Budgeting methods employed in Stutz plant for use in manufacturing automobiles discussed; without use of any special forms, this manufacturer has been able to predict his income and expenditures to degree of accuracy that is exceptional; accounting department uses sales forecast by management as basis; make-up of direct manufacturing expense schedule; month-by-month expenditure and month-by-month financial forecast schedules; keeping foremen to expense schedule.

AUTOMOBILES

Clutches. New Automobile Clutch Control Developed. Automotive Industries, vol. 60, no. 10, Mar. 9, 1929, p. 417, 1 fig. Details of system of automatic clutch control developed by Erdelen, German engineer, for which it is claimed that it tends to greatly facilitate car driving.

Design. Current Trends in Passenger Car Design. Automotive Industries, vol. 60, no. 8, Feb. 23, 1929, pp. 284–285, 15 figs. Trend in passenger-car design during 1928 are shown in charts and graphs, covering maximum horsepower, compression ratios, oil cleaners, minimum turning circle, division of 4-wheel brakes, air cleaners, steering gears, front-end drives, clutch types, number of crankshaft bearings, piston materials, makes and models, valve location, number of cylinders, and type of rear axle.

Front-Wheel Drive. Front-Wheel Drive Car is Produced in France. Automotive Industries, vol. 60, no. 10, Mar. 9, 1929, p. 414. Details of front-wheel drive car, carrying 6-cylinder Hispano-Suiza engine and having four independently sprung wheels, produced in Paris by Andre Dubonnet; chassis designed to incorporate patented front wheel drive features of Tracta automobile all-aluminum body; low overall height.

Research Apparatus. Demonstration Devices Displayed. Soc. Automotive Engrs. Jl., vol. 24, no. 2, Feb. 1929, pp. 244–245, 11 figs, on p. 243. Description of research apparatus used in Detroit meeting for elucidating papers; apparatus to show physical state of fuel in gasoline engines; apparatus for studying flame propagation; bearing lubrication indicator; engine for knock testing; dragometer and shiftometer; valve-spring vibration indicator.

Springs and Suspension. Coil Spring Suspension. Autocar (Lond.), vol. 62, no. 1735, Feb. 1, 1929, p. 235, 3 figs. Details of Horstman system; whereby each wheel can be independently sprung; coil springs under compression are used and load is taken through system of levers so arranged that springs progressively gain advantage over load.

Transmissions, Hydraulic. Principles Underlying Design of Hydraulic Gears with Whirling Disks, with Special Reference to Automobile Construction (Ueber die Konstruktionsgrundlagen von Fluessigkeitsgetrieben mit Taumelscheibe), K. Schlaefke. Motorwagen (Berlin), vol. 32, nos. 2 and 3, Jan. 20 and 31, 1929, pp. 28–32 and 59–62, 18 figs. Nature of transmission gears is discussed; properties and types of hydraulic gears; principles underlying use of whirling disks; conditions governing motion of whirling-disk gear and principles underlying design.

AUTOMOTIVE FUELS

Anti-Knock Compounds. Metallic Anti-Detonants, H. S. Tegner. Flight (Lond.), vol. 21, no. 5, Jan. 31, 1929, (Aircraft Engr.), pp. 3–5. Various anti-knock compounds for airplane fuels are discussed; description of investigation under-

taken by T. Midgeley and T. A. Boyd in General Motors Research Laboratories, Dayton, Ohio; tetraethyl lead found by far most effective in anti-knock value; properties and disadvantages of iron carbonyl and German Motalin; disadvantages of nickel carbonyl; British thallium; methods of manufacturing tetraethyl lead employed by Du Pont Chemical Corp.; aviation uses in United States and Great Britain.

Detonation. Standard Engine for Fuel Tests. Soc. Automotive Engrs. Jl., vol. 24, no. 2, Feb. 1929, pp. 212–213, 2 figs. Details of research program of Subcommittee on Methods of Measuring Detonation of Cooperative Fuel Research Steering Committee, and description of standard engine built for Subcommittee as first step in testing fuel knock.

French Substitute Fuels. French Endeavor in the Field of Substitute Fuels and the Third Franco-Belgian Convention on National Fuels (L'effort francais pour les carburants de remplacement et le 3 rallye des carburants nationaux Franco-Belge), G. Kimpflin. Société d'Encouragement pour Industries Nationale Bul. (Paris, vol. 127, no. 12, Dec. 1928, pp. 890–913 and (discussion) 914–916, 10 figs. Address reviewing recent progress in utilization of alcohol, benzene, producer gas etc., as gasoline and petroleum substitutes.

B

BALANCING

Rotating Parts. Balancing Rotating Part by a New Method. Machy (Lond.), vol. 33, no. 854, Feb. 21, 1929, pp. 664–667, 5 figs. Description of Olsen-Lundgren process in which amounts and angular locations of static and dynamic unbalance in parts are determined without rotating work at critical speed.

BALANCING MACHINES

Dynamic. Portable Dynamic Balancing Outfit, P. Davey. Iron Age, vol. 123, no. 9, Feb. 28, 1929, pp. 610–612, 6 figs. See also Mach. (N. Y.), vol. 35, no. 7, Mar. 1929, pp. 532–535, 7 figs. Design and operation of Davey dynamic balancing equipment are described; stroboscopic principle is used to explore vibration in machines; both static and dynamic unbalance is covered.

BEARINGS, BALL

Manufacture. The Works of the Skefko Ball Bearing Co., Ltd. Automobile Engr. (Lond.), vol. 19, no. 251, Feb. 1929, pp. 43–48, 13 figs. Notes on extensions and new methods in factory at Luton are described; attention principally to methods capable of general application; characteristics of steel and microstructure; continuous and regenerative types of furnaces for hardening rings; machining operations and machines described; taper ball bearings; inspection and tests; gaging balls.

BEARINGS, THRUST

Michell. Notes on the Fitting and Operation of Michell Bearings, J. F. Petree. Engineer (Lond.), vol. 147, no. 3811, Jan. 25, 1929, p. 111. Probably more than 90 per cent of such troubles as were met with in running of Michell bearings could be attributed to insufficiency of oil or to dirty oil; lubricants can be applied in three ways, plain bath lubrication, flooded lubrication and force feeds; there is no truth in assertion sometimes made that forced lubrication pump is necessary adjunct to Michell bearing.

BLAST FURNACES

Germany Practice. Blast-Furnace Practice in Germany, F. H. Willcox. Foundry Trade Jl. (Lond.), vol. 40, no. 651, Feb. 7, 1929, p. 112. Burdens found at various plants are of most composite character because of wide sources of supply; not much low-grade ore used; sintering African ores difficult; German furnace construction is inversion of American, that is, brick stack with steel bands with cooling plate set in, and steel-plate bosh and tuyere jacket without plates, water-cooled on exterior. Abstract of address before East. States Blast Furnace and Coke Oven Assn.

BOILER FEEDWATER

Treatment. Concentration Control Provides Good Quality Boiler Feed Water, L. A. Fritze and E. W. Scarrit. Power, vol. 69, no. 9, Feb. 26, 1929, pp. 346, 349, 4 figs. Correct condition of feedwater in conjunction with deconcentrating apparatus provides clean boiler water with low coefficient of insoluble concentration; presence of uncontrolled caustic in boiler water leads to embrittlement; type of concentration decides system; operating economy is governing factor; oil filters should be used with deconcentrating equipment.

BOILER FIRING

Low-Grade Fuels. Burning of Coke Breeze and Blast Furnace Gas Under Steam Boilers, R. C. Denny and O. de Lorenzi. West. Soc. of Engrs. Jl., vol. 34, no. 3, Mar. 1929, p. 177–88 and (discussion) 188–190, 9 figs. Advantages of different kinds of boiler settings and furnaces with reference to solid and gaseous fuel; how breeze is made; how blast-furnace gas is made; coke-breeze furnaces; importance of sizing breeze; gas furnaces; combination furnace design; combination furnaces proved practical.

Pulverized Coal. Coal Dust Firing for Boilers and Industrial Furnaces, H. Berg and E. Vogt. Colliery Guardian (Lond.), vol. 138, no. 3552, Jan. 25, 1929, p. 344 and (discussion) 344–345. Storage of coal; drying; pulverization; bunkering coal dust; dust combustion chamber; opinion is expressed that rotary coal dust fired melting furnace is destined to produce revolution in foundry practice. From paper read before Inst. of Fuel.

BOILER FURNACES

Water-Cooled. A Method for Determining Velocity of Circulation in Water-Wall Tubes, E. S. Smail. Power, vol. 69, no. 10, Mar. 5, 1929, pp. 411–413, 3 figs. High rates of steam generation obtained in furnace water walls have served to stimulate attention given to water circulation in them; author has simplified calculation of velocity of water and steam mixture in tubes of water walls.

BOILER TUBES

Heat Transmission Through. Heat Transmission and Heat Absorption of Ribbed Tubes (Waermedurchgang und Waermeaufnahme von Rippenrohren), E. Neussel. Archiv fuer Waermewirtschaft (Berlin), vol. 10, no. 2, Feb. 1929, pp. 51–56, 18 figs. Heat equations for round and quadratic fins and for entire ribbed tube are given and compared with operating results; investigation of different kinds of ribbed tubes and ribs of different dimensions on thermal efficiency.

BOILERS

Atmos. Developments in the "Atmos" Boiler, J. V. Blomquist. Eng. and Boiler House Rev. (Lond.), vol. 42, no. 8, Feb. 1929, pp. 397–399, 6 figs. Particulars of boiler which has been in service for over two years; description of new squirrel-cage rotor used in latest Atmos boilers; rotor consists of central tube, surrounded by 12 straight tubes of 80 by 102 mm. diam., lying on circle of 660 mm. diam.; with this equipment running at 13 r.p.m., evaporation of 4000 kg. per hr. was obtained, inlet temperature of water being 270 deg. cent.; central and peripheral tubes can expand and contract freely.

Control. Automatic Combustion Control for Boiler Furnaces. Power Engr. (Lond.), vol. 24, no. 275, Feb. 1929, pp. 68–71, 8 figs. Enco system is described; demand is detected by regulator but movement of regulator merely controls speed of forced-draft fan; control of stack damper follows from furnace-pressure controller; mounted on side wall of furnace, which alters position of stack or breeching damper to keep furnace pressure constant irrespective of air supply; fuel-bed resistance; electrical system.

Thermotechnical Control in Large Central Stations (Waermetechnische Ueberwachung von Grosskraftwerken), A. Grunwald and W. Liesegang. Waerme (Berlin), vol. 52, no. 4, Jan. 26, 1929, pp. 49–57, 18 figs. Use of electric measurements and remote-control instruments are recommended; description of annular-tube remote recorder for instruments measuring volume, pressure, and draft; possibility of attaching all kinds of heat-control instruments to multiple-color recorder; most important measurements on high-duty boilers; feed water control with electric tester; control of coal-pulverizing plants.

Corrosion. Reducing Corrosion Trouble in Boilers, H. S. Rawdon and K. H. Logan. Iron Age, vol. 123, no. 10, Mar. 7, 1929, p. 666. Means of reducing corrosion trouble in boilers and allied equipment are discussed; steel which should be entirely satisfactory made worthless by brutal treatment it received during erection of installation; any operation tending to produce abrupt changes in structural conditions of steel should be avoided as potential sources of trouble; steel which has shown itself to have superior acid-resisting properties should be suitable. Abstract of paper before Mid-West Power Eng. Conference.

Feed Circuits. Modern Feed-Water Circuits. J. G. Weir. Mech. World (Manchester), vol. 85, nos. 2197, 2198, and 2199, Feb. 8, 15, and 22, 1929, pp. 123–125, 154–155 and 174–175, 19 figs. Feb. 15: Make-up feed and correct pressure datum to employ; system with low-pressure evaporator, other methods outlined. Feb. 22: Methods of reheating steam are described; single high-pressure boiler with air preheater, economizer, and multiple-stage feedwater heating; two water-tube and one capacity-type boiler arranged to give polytropic steam generation; binary fluid system. Paper read before Instn. Mech. Engrs. Feb. 8: Characteristics of various circuits studied by means of diagrams; methods of controlling amount and distribution of working fluid in boiler; construction of direct-contact feed-heater and deaerator; various arrangements of feed heaters to increase thermal efficiency of practical feed cycle.

Heads. Strengthening of Weak Boiler Heads (Ueber die Verstaerkung von schwachen Dampfkesselboeden), E. Hoehn. Archiv fuer Waermewirtschaft (Berlin), vol. 10, no. 2, Feb. 1929, pp. 48–50, 13 figs. Various methods are employed for strengthening boiler heads; among most satisfactory is welding on of rings; boiler head strengthened in this manner was tested and results are given.

High Pressure, Welding. Welding Used in High Pressure Boiler, K. A. Mayr. Power Plant Eng., vol. 33, no. 4, Feb. 15, 1929, pp. 260–261, 2 figs. Small bore tubes joined satisfactorily by thermit process; tube ends are ground flat and, pressed together by means of clamps; casting mold is fitted around joint and filled with right amount of molten aluminum and iron is sufficiently transferred and distributed over oxide and iron oxide and iron; after casting mold has been filled, heat from aluminum oxide and iron is sufficiently transferred and distributed over tube ends to be jointed, and these ends are pressed together still more tightly by means of clamps.

Pulverized-Coal-Fired. Design of Pulverized-Coal Combustion Chambers for Boilers (Bauformen von Kohlenstaub-Brennkammern fuer Dampfkessel), P. Krebs. Waerme (Berlin), vol. 52, no. 4, Jan. 26, 1929, pp. 81–85, 12 figs. Particulars of design and production costs; combustion-chamber load; large furnaces with radiation zones; furnaces without cooling grates, and with ignition zones; Haack uniflow, uniform-pressure chamber; use of locomotive firing system for stationary boilers; other types of furnaces; pulverized-coal firing for fire-tube boilers.

BRASS

Heat Treatment. Some Observation in Heat Treatment of Muntz Metal, L. R. Van Wert. Am. Inst. Min. and Met. Engrs.—Tech. Pub., no. 180, Feb. 1929, 10 pp. 15 figs. Notes on cleavage structure developed under certain conditions, and on abnormal grain growth, in alloy of 60 per cent copper and 40 per cent zinc; preliminary survey only, promoted by observations made during investigation of solubility relations.

Metallurgy. Brass and Special Brasses (Messing und Sondermessing), W. Wunder. V.D.I.-Zeit. (Berlin), vol. 73, no. 5, Feb. 2, 1929, pp. 165–168, 13 figs. Old and new methods of making zinc-copper alloys, phase-rule diagrams and texture; elimination of initial strains; recrystallization phenomena; making of special brasses by adding aluminum, lead, tin, or other metals.

Research. High-Strength Brasses, O. W. Ellis. Am. Instn. Min. and Met. Engrs.—Tech. Pub., no. 167, Feb. 1929, 25 pp., 14 figs. Discussion of effects of various elements commonly added to brass for purpose of increasing its strength; results of investigation and tests of alloys containing tin, iron, aluminum, manganese nickel, in varying degree. Bibliography.

C

CARS

Dynamometer. Northern Pacific Builds New Dynamometer Car. Ry. Age, vol. 86, no. 6, Feb. 9, 1929, pp. 363–366, 7 figs. New-all-steel dynamometer car built in Como shops; St. Paul, has capacity to measure drawbar pull up to 250,000 lb. and buff up to 1,250,000 lb.; car is 9 ft. $3^1/_8$ in. wide by 70 ft. long inside and weighs 168,600 lb.; living accommodations; heating and lighting equipment; dynamometer equipment; selective switch box in dupola.

CAST IRON

Heat Treatment. Heat Treatment and Properties of Cast Iron, P. Schoenmaker. Blast Furnace and Steel Plant, vol. 17, no. 2, Feb. 1929, pp. 283–286, 10 figs. Effect of controlled initial melting temperatures and of subsequent heat treatment are studied; various elements affecting properties; effect of treatments on hardness; physical properties of hardened and tempered cast iron.

Properties. Carbon-Silicon Relation Deter-

mines Suitability of Iron for Casting, D. G. Anderson and G. R. Bessmer. Foundry, vol. 57, no. 3, Feb. 1, 1929, pp. 106–108, 5 figs. Description of series of experiments undertaken to determine possibility of improving gray cast iron by reducing carbon content; as carbon content is reduced free carbon formation is changed from flakes to round shapes, making structure of iron stronger, as physical tests show. Abstract of paper presented before Am. Foundrymen's Assn.

CHROMIUM-NICKEL STEEL

Corrosion. Resistance of Iron-nickel-chromium Alloys to Corrosion by Acids, N. B. Pilling and D. E. Ackerman. Am. Inst. Min. and Met. Engrs.—Tech. Pub., no. 174, Feb. 1929, 33 pp., 16 figs. Tests on 90 experimental melts covering portion of range containing 30 per cent chromium or less; technique of corrosion testing; hydrogen-discharging acids; sulphurous acid and mixtures thereof; effect of constitution and heat treatment; tabular data and diagrams of results of tests.

Welding. Problems in Welding Chrome-Nickel, E. D. Flinterman. Welding Engr., vol. 14, no. 2, Feb. 1929, pp. 41–44, 6 figs. Alloys with high coefficient of expansion, low heat conductivity, and coarse, irregular grain present difficult welding problem; in welding carbonizing boxes, welds cracked on cooling; plates easily welded on edges but not in center; results of tests; carbon arc makes welds on Misco very much faster than gas, but they are not as good physically; welding rolled Misco. Paper read before Welding Conference at Purdue University.

COAL HANDLING

Equipment, German. Port Facilities of the Fuerst Hardenberg Coal Mine (Hafenverladung der Zeche Fuerst Hardenberg), D. P. Schoenfeld. V.D.I.-Zeit. (Berlin), vol. 73, no. 6, Feb. 9, 1929, pp. 191–195, 14 figs. Features of 25-ton two-tub cars, loading bridges, traveling cranes, electric motors and other equipment of canal port of coal mine near Dortmund; construction of canal wharves.

COMBUSTION

Automatic Control. Automatic Combustion Control, T. A. Peebles. Inst. of Fuel—Jl. (Lond.), vol. 2, no. 6, Jan. 1929, pp. 132–140 and (discussion) 141–154, 13 figs. Quantities of fuel and air in boiler plant must be varied according to demand; difficulties in metering coal supply to stoker, and in metering air supply; effective means by which automatic control distributes load equally among boilers and at same time compensates for varying fuel-bed resistances; operation of plant in which air supply was regulated so as to maintain pressure in air compartment of burner equal to pressure of gas in gas chamber.

CONVEYORS

Electric Motors for. Selection of Motors for Driving Conveyors, R. F. Emerson. Cassier's Indus. Mgmt. (Lond.), vol. 16, no. 2, Feb. 1929, pp. 44–45. Owing to its greater simplicity, smaller initial cost, higher efficiency and lower maintenance charges, squirrel-cage motor is generally used for conveyor drives, particularly in smaller sizes; squirrel-cage motors differ in design mainly in their starting torque and inrush currents; high resistance winding; full voltage starting; employment of compound motors; magnetic sequence control. From Power, Nov. 13, 1928.

COOLING TOWERS

Reinforced-Concrete. High-Capacity Reinforced-Concrete Cooling Tower (Ein Hochleistungs-Kuehlturm aus Eisenbeton), W. Werner. Archiv fuer Waermewirtschaft (Berlin), vol. 10, no. 2, Feb. 1929, pp. 37–43, 10 figs. Particulars of new installation of Trattendorf power plant which supplies electric power to Berlin; tower has sprinkler walls in parallel arrangement; these walls are made of porous clay brick; operating results are given and compared with towers of other design.

COPPER ALLOYS

Copper-Silicon, Corrosion of. Resistance of Copper-silicon-manganese Alloys to Corrosion by Acids, H. A. Bedworth. Am. Inst. Min. and Met. Engrs.—Tech. Pub., no. 189, Mar. 1929, 14 pp., 16 figs. Commercial development of this type of alloy is recent; discussion of research by various investigators; description of tests on hard-drawn and annealed wires, of varying composition, after alternate immersion in dilute hydrochloric and dilute sulphuric acids; relative corrosion determined by measuring loss in weight, tensile strength, and elongation; discussion of results.

Heat Treatment. Heat Treatment and Mechanical Properties of Some Copper Zinc and Copper-Tin Alloys Containing Nickel and Silicon, W. C. Ellis and E. E. Schumacker. Am. Inst. Min. and Met. Engrs.—Tech. Pub., no. 188, Mar. 1929, 17 pp., 8 figs. Mechanical properties can be varied over wide range by suitable heat treatment; these alloys may have possibilities in manufacture of high strength brass castings; hardening by heat treatment would permit forming operation on manufactured part to be performed on soft material.

CRANES

Bridge. Loading Bridge for Sectional Materials. Demag News (Duisburg), vol. 3, no. 1, Jan. 1929, pp. 23–24, 2 figs. Details of loading bridge for unloading rolled sections from railway trucks; two portable lattice bridges of steel interconnected by transverse tie beams.

CUTTING TOOLS

Design. Machine Tool Operation—Problems in Cutting. Times Trade and Eng. Supp. (Lond.), vol. 23, no. 550, Jan. 19, 1929, p. 472. Discussion of vital factors which have to be taken into account when designing and operating machine tools if cutting efficiency is to be maintained, these include questions of speeds, pressures deflection, shock, heat, endurance, etc.

Tungsten Carbide. Grinding Tungsten Carbide Tools, A. H. Prey. Iron Trade Rev., vol. 84, no. 9, Feb. 28, 1929, p. 590. Recommendations for grinding cutting tools of carboloy, Strauss metal, dimondite, widia and other tungsten carbide materials, made by Norton and Carborundum Companies are discussed; three operations, rough grinding, finish grinding and stoning or honing, are recommended for new alloys.

Tungsten-Carbide Tool Efficiency, G. S. Brady. Am. Mach., vol. 70, no. 9, Feb. 28, 1929, p. 346, 2 figs. Description of endurance tests of tungsten carbide cutting tools run at Philadelphia Navy Yard; when operated under proper working conditions, and for purposes intended, they will cut hard and tough steels at higher speeds than have ever been attained by high-speed steels; when working at high speeds without overtaxing tools, they will stand up indefinitely without resharpening, thus making great savings in grinding and set-up time; economical operating speeds.

D

DIES

Forging, Heating Treatment of. English and American Die Tool Steels, J. W. Urquhart. Heat Treating and Forging, vol. 15, no. 2, Feb. 1929, pp. 177–182, 1 fig. Review of contrasting composition as well as hardening, tempering and general thermal treatments; divergencies in practice; constitution of some English nickel-chromium steels; air-hardening properties of English steels; ratio of air-hardening to water-quench hardening; influence of rate of cooling of nickel-chromium steels; best alloy steels for die making; molybdenum alloys; heating and cooling ranges of die steels; American cold heading dies.

Steels for. High Carbon High Chromium Steels, J. P. Gill. Am. Soc. Steel Treating—Trans., vol. 15, no. 3, Mar. 1929, pp. 387–420 and (discussion) 420–428, 90 figs. Comparison of properties of six steels of high-carbon, high-chromium class, which during recent years, have become so popular as die steels; critical points, hardening and tempering curves, micro-structure and physical properties are covered; constitution of steels of this class; brief historical outline of development of these steels.

DIESEL ENGINES

Design. A Survey of Diesel and Semi-Diesel Practice. Gas and Oil Power (Lond.), vol. 24, no. 281, Feb. 7, 1929, pp. 97–98 and 100. Development of early Diesel engines; advantages and limitations of four-cycle and two-cycle engines Sulzer charging and scavenging system; marine Diesel engines; Doxford engine; Diesel engine using coal-dust as fuel has again come to front.

Fuel Systems. A Diesel Engine Uses Hot Air for Fuel Injection, N. McCarty. Power, vol. 69, no. 11, Mar. 12, 1929, pp. 429–430, 6 figs. High-speed two-stroke-cycle Diesel is described which uses hot air instead of cold air or pump pressure for injection of fuel; method of shifting timing of rotary scavenging valve; engine has 6 single-acting cylinders, of $7^1/_2$-in. bore and 10-in. stroke; at 600 r.p.m. each cylinder delivers 50 b.hp., with indicated m.e.p. of 112.5 lb.

Marine, Double-Acting. Richardsons-Westgarth Double-Acting Oil Engine. Power Engr. (Lond.), vol. 24, no. 275, Feb. 1929, pp. 56–59, 5 figs. First all-British two-stroke cycle double-acting engine, employs airless injection on controlled-pump system; simplicity and accessibility are good features of design; cylinder construction; engine for single-crew 3000-ton oil tanker now nearing completion; has three cylinders and is arranged to drive its own reciprocating scavenge pump; cylinders are $21^1/_2$ in. in diam. with piston stroke of 38 in.; 1200 b.hp. will be developed in service at 89 r.p.m., while 1425 b.hp. can be produced at 105 r.p.m.

Marine, Supercharging. Turbo-Charging of Internal-Combustion Engines, Especially Diesel Engines, A. Buechi. Mar. Engr. and Motorship Bldr. (Lond.), vol. 52, no. 617, Feb. 1929, pp. 48–52, 5 figs. Combustion pressure and heat-transfer stresses; Diesel engine for passenger liner; comparison of size and weight, fuel and lubricating-oil consumption of 36,000-b.hp. marine Diesel installation with various types of engine; comparison of various types of marine oil engine and of 9000-s.hp. Diesel engines; various engine-room arrangements for quadruple-screw, 36,000-s.hp. motor liner. Abstract of paper before Inst. Mar. Engrs.

E

ELECTRIC FURNACES

Heat-Treating. Electricity Used in the Heat-Treatment of Metals, A. N. Otis. Am. Mach., vol. 70, no. 7, Feb. 14, 1929, p. 284. Advantages of electric furnaces employed in heat treatment are discussed; carburizing furnaces; annealing tool steel and alloy-steel bar stock in electric furnaces; savings of electric furnaces computed; furnaces for heating brass for deep drawing; electric furnaces particularly well adapted for applying vitreous enamel. Abstract of paper presented before Western Metal Congress.

The Electric Furnace for Hardening Steel, E. L. Hill. Elec. Engr. of Australia and New Zealand (Melbourne), vol. 5, no. 10, Jan. 15, 1929, pp. 353–358, 6 figs. Hardness and wearing quality of steel depends upon quenching taking place at exact moment; pyrometrical observation is not sufficiently accurate to give consistent results; accurate gaging by observing magnetic quality; in Wild-Barfield furnace, steel is heated electrically and automatic measurement is made of its magnetic quality by indicator which gives positive reading showing correct moment for quenching; other high-temperature furnaces used for hardening of alloy steels also described.

ELECTRIC WELDING ARC

Machines for. Automatic Arc-Welding Machines (Selbsttaetige Lichtbogen-Schweissmaschinen), F. Niethammer. V.D.I.-Zeit. (Berlin), vol. 73, no. 7, Feb. 16, 1929, pp. 209–219, 36 figs. Characteristics of automatic arc-welding machines; descriptions of machines made by Siemens-Schuckert, General Electric Co., Stahl und Eisen Handelsgesellschaft, and others; methods of operation in welding of straight and curvilinear joints, welding of housings of electric machines; suggestions for automatic welding process.

F

FLUE GASES

Analysis. How Much Goes Up the Chimney? D. M. Myers. Power, vol. 69, no. 11, Mar. 12, 1929, pp. 437–440, 6 figs. Dollars and cents analysis of boiler losses; chart for readily determining these losses; how to reduce them to minimum; check consists of analysis of gases leaving boiler and temperature of these gases; specific causes of excessive stack losses.

FORGING

Forge-Shop Practice. Forge Heating for Large Pieces, J. R. Miller. Heat Treating and Forging, vol. 15, no. 2, Feb. 1929, pp. 219–220, 2 figs. Miscellaneous heavy products introduce complications not incident to heating of similar parts in mass production; fuel consumption figures are difficult to interpret; fuel economy; choice of fuels; pulverized coal admits of close regulation when proper arrangements have been made for its application.

G

GEARS

Chain, Stresses in. Stresses in Chain Gearing, S. E. Clevely. Machy. (Lond.), vol. 33, nos. 853 and 854, Feb. 14 and 21, 1929, pp. 629–

632 and 661–663, 8 figs. Feb. 14: Loads or tensions present in chain actually functioning dynamically are discussed; calculation of pull due to centrifugal tension and dead weight or catenary tension. Feb. 21: Calculation of pull due to horsepower transmitted; total tension in chain; pull on shafts and shaft bearings; combined load and centrifugal tension in chain; impactive loads.

Impact Effects. Dynamic Effects in Gear Drives (Dynamische Wirkungen im Zahnraedertrieb), A. Schiebel. Maschinenbau (Berlin), vol. 8, no. 2, Jan. 17, 1929, pp. 47–48. Gears poorly fitting cause impact effects; derivations of impact formulas.

Worm, Research in. Investigation of Cylindrical Screw Drives (Worm Gearing) (Untersuchungen an Zylinderschraubgetrieben), F. G. Altmann. Maschinenbau (Berlin), vol. 8, no. 2, Jan. 17, 1929, pp. 3–47, 12 figs. Determination of losses resulting from design of gears and flank action; it is concluded that similar gearing distinguished only by form of flank hardly shows difference of losses; physical layout of cylinder cuts.

GRINDING

Precision. Close Grinding Limits and High Production Necessary in Magneto Manufacture, B. K. Price. Abrasive Industry, vol. 10, no. 3, Mar. 1929, pp. 89–91, 3 figs. Precision grinding methods in plant of Splitdorf-Bethelehem Electrical Co., Newark N. J., employed in manufacturing magnetos, are described; on some parts as high as nine grinding operations are performed; 0.0005-in. limits on two bearing dimensions; grinding cams.

GRINDING MACHINES

Tables. Rotary or Reciprocating Tables for Vertical Surface Grinding Machines, C. Krug. Machy. (Lond.), vol. 33, no. 851, Jan. 31, 1929, pp. 565–566, 4 figs. Manner in which metal is removed from workpiece when operating with rotary table and stresses to which grinding wheel is subjected during operation are discussed; marked irregularities in removal of metal and in load on grinding wheel call for unusually large driving motors; other advantages and limitations of rotary tables; preference given to reciprocating table when using heavy surface grinding machines. From Maschinenbau.

H

HEAT

Conductivity. A Survey of Heat Conduction Problems. Jl. of Sci. Instruments (Lond.), vol. 6, no. 1, Jan. 1929, pp. 28–32, 3 figs. Discussion of practical difficulties in determining thermal conductivity of materials in whatsoever form they were supplied, which ranged from mica sheets to half-ton wall sections; various forms of apparatus for determining thermal conductivity of cold-storage insulators and furnace materials; conduction through granulated substances; apparatus for studying heat transmission through laminated stampings; thermal conductivity of metals and alloys. Abstract of paper presented before Phys. Soc.

HIGH-SPEED STEEL

Heat Treatment. A New Method for Heat Treating High Speed Steel, H. C. Knerr. Am. Soc. Steel Treating—Trans., vol. 15, no. 3, Mar. 1929, pp. 429–445 and (discussion) 445–450, 8 figs. Features of method described include electrical heating, close temperature control which may be made automatic, use of salt bath which does not give off fumes or attack tools, prolonged container life, absence of furnace deterioration, comfortable working conditions, low heating cost per pound of steel, and ability to employ full hardening temperatures without injury to finished surfaces or cutting edges of high-speed steel tools.

I

ICE MANUFACTURE

Continuous. Machinery for Continuous Ice Production, C. Field. Refrig. World, vol. 64, no. 2, Feb. 1929, pp. 12–17, 10 figs. New product is described called Flakice which consists of thin sheets of ice produced by noval equipment; normally in operation, these sheets of ice are broken into small pieces roughly rectangular in plan.

New Developments in. Recent Developments in Ice Manufacture, S. E. Lauer. Refrigeration, vol. 45, no. 2, Feb. 1929, pp. 78–82, 2 figs. Consideration in determining number of cans per ton that should be installed; recommendations for harvesting 1-man per shift operation; Artic-Pownall system; question of proper suction pressure, and what is justifiable form of investment in tank, evaporator surface, agitation and like, in order to get highest practical suction pressure. Read before East. Ice Assn.

INDUSTRIAL MANAGEMENT

Budget Control. Manufacturing Budget Controls, K. M. Goggeshall. Iron Age, vol. 123, no. 8, Feb. 21, 1929, pp. 527–532, 5 figs. Description of how budget control system may be made to work satisfactorily; method of Wagner Electric Corp.; inventory of stock and parts in process tied in with analysis which is revised monthly; delays and over-supply avoided; purchase orders made from ledger record; how follow-up system is operated.

Profits by Careful Budgeting, M. P. Sullivan. Iron Age, vol. 123, no. 10, Mar. 7, 1929, pp. 661–663 and 691, 2 figs. Methods of business forecasting and control employed by National Automatic Tool Co., Richmond, Ind., are described; forecasting rises and falls in demand adds profits and checks losses; logarithmic chart of orders used as a key to forecasts; material record cards show every item carried in stock; cost of every machine part recorded on card; material record card a perpetual inventory

Cost Accounting. Control of Labor Expense, H. M. Grasselt. Mfg. Industries, vol. 17, no. 2, Feb. 1929, pp. 107–110, 4 figs. Methods which hold down one of most important elements in manufacturing costs, developed from experiences of fine-paper mills; departmentalization; wage-payment systems; timekeeping; foreman's daily labor distribution sheet; analysis of payroll record.

How Standard Costs Assist the Production Engineer, H. E. Kearsey. Mech. World (Manchester), vol. 85, no. 2198, Feb. 15, 1929, pp. 152–154, 1 fig. Details of new systems of cost accounting known as standard costing which operates through comparison of actual costs against standard or predetermined costs; cost allocations, standard costs, and cost control accounts are explained; planning of manufacturing methods is essential factor to standard costing.

Simplified Manufacturing Accounts, J. J. Berliner. Mill and Factory Illustrated, vol. 3, no. 2, Feb. 1929, pp. 32–33, 70 and 72, 6 figs. System of accounts for moderate-sized manufacturing concern whose business does not warrant large office staff or system involving multitude of details; basic principles of accounting are carefully adhered to and forms used are in common use by large number of manufacturing firms; system is one that is stripped to essentials.

Labor Turnover. Your Labor Turnover Rate—How Does it Compare with Average? Automotive Industries, vol. 60, no. 6, Feb. 9, 1929, pp. 206–207, 3 figs. Information for guidance of production and personnel managers furnished by study of factory statistics on hiring and firing in Michigan and United States; turnover data for United States supplied by Metropolitan Life Insurance Co. and for Michigan by Bureau of Business Research, University of Michigan.

Production Control. $250,000 Inventory Cut by Better Handling, G. T. Willson. Mfg. Industries, vol. 17, no. 2, Feb. 1929, pp. 93–98, 8 figs. Reorganized methods of production control and small investment in equipment make big reduction in cost of work and in number of parts in process at De Laval plant; after decision that installation of conveyors in plant was not warranted by savings which could be shown, system of chutes between machines doing consecutive operations on some of major parts, were tried out; plan of manufacturing; special platforms; plan of ordering and scheduling parts used; control methods.

Profit-Making. Conditions of Profit-Making Management, H. S. Person. Soc. of Indus. Engrs.—Bul., vol. 11, no. 1, Jan. 1929, pp. 3–6. Author considers briefly some of changes which have taken place in conditions of management, in practical concepts of profit making, and in management principles and procedures.

Purchasing. Specification and Procurement of Manufacturing Materials, F. J. Oliver, Jr. Am. Mach., vol. 70, no. 9, Feb. 28, 1929, pp. 341–343, 4 figs. Description of material purchasing methods used in plant of Morrison Machine Co., Paterson, N. J., which employs about a hundred men in making general line of machinery; several management functions are spread over a few individuals; chief engineer is responsible for both production and purchasing; only few simple forms are used to control all material purchases.

INDUSTRIAL RESEARCH

Returns from. Research the Foundation of Progress, L. P. Alford. Mfg. Industries, vol. 17, no. 2, Feb. 1929, pp. 117–22, 6 figs. Extensive programs adopted by large number of successful industries are yielding huge returns on investments and big savings; backward industry is one doing no research; presentation of research as it is being conducted in American manufacturing with particular emphasis upon cooperative efforts and developments of new and improved processes.

INDUSTRIAL TRUCKS

Lift. Milwaukee Finds Profit in Lift-Truck Operations, J. V. Miller. Ry. Age, vol. 86, no. 7, Feb. 16, 1929, pp. 399–402, 8 figs. In stores department of Chicago, Milwaukee, St. Paul, and Pacific, new applications of lift-truck handling are being developed every week; brake-shoe handling revolutionized; use of lift trucks and skids for handling pumps, tires, ship break beams, car journal bases; skids to cheapen scrap handling. From paper before Am. Soc. Mech. Engrs.

Wheel Skids. Wheel-Skids Lower Production Cost, S. G. Koon. Iron Age, vol. 123, no. 7, Feb. 14, 1929, pp. 467–470, 7 figs. Various uses of wheel skids in Philadelphia plant of General Electric Co. are described; they are used to carry material from railroad cars, to feed assembly units, to serve manufacturing machines, and as storage racks; how wheel skids are made; use of skids in stockroom; handling materials in assembling units; testing each unit before shipping.

INTERNAL-COMBUSTION ENGINES

Efficiency. Effect of Intake Pipe on the Volumetric Efficiency of an Internal Combustion Engine, A. Capetti. Nat. Advisory Committee for Aeronautics—Tech. Memorandums, no. 501, Feb. 1929, 22 pp., 11 figs. Most favorable pipe length for charging, which can be adopted without disturbing carburation by using additional pipe preceding carburetor; effect of using same pipe for several cylinders; experimental confirmation from American and writer's experiments; inertia. From Annalli della R. Scuola d'Ingegneria di Padova, Dec. 1927.

On the Thermal Efficiency of Standard Cycles for Internal Combustion Engines, H. H. Jeffcott. London, Edinburgh, and Dublin Philosophical Mag. and Jl. of Sci. (Lond.), vol. 7, no. 42, Feb. 1929, pp. 386–399, 9 figs. Account of simple method for calculation of thermal efficiency of certain standard cycles for internal-combustion engines using as working fluid air or other real gas of which specific heats vary with temperature.

Two-Cycle. Crankcase Scavenging for Two-Stroke Engines (Kurbelkastenspuelung fuer Zweitaktimotoren), H. List. V.D.I.-Zeit. (Berlin), vol. 73, no. 7, Feb. 16, 1929, pp. 225–228, 16 figs. Air consumption in two-stroke internal-combustion engines with crankcase scavenging computed and results graphically represented; experimental determination of efficiency of supply; method allows calculation of mean piston pressure and favorable length of intake slot.

Novel Piston Arrangement Devised for Two-Cycle Engine. Automotive Industries, vol. 60, no. 7, Feb. 16, 1929, pp. 244–245, 3 figs. Details of internal-combustion engine working on two-stroke cycle and using either preformed mixture, electric-ignition, or Diesel compression-ignition principle, developed by Wilhelm Bertil Bronander; port action improved by use of two working pistons which are connected to opposite ends of T on compressor piston connecting rod; tests now in progress; three pairs of working cylinders used and cranks set at 120 deg. with each other.

[See also AIRPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; OIL ENGINES.]

IRON AND STEEL PLANTS

Steam Generation in. Review of Certain Developments in Fuel Burning and Steam Generation During 1928, C. Stripe. Iron and Steel Engr., vol. 6, no. 1, Jan. 1929, pp. 7–11, 6 figs. Important advancements made in fields of fuel burning and steam generation; overall monthly efficiencies of 90 per cent are matter of record; steam capacities of 1,000,000 lb. per hr., from single unit, are now commercially available; steam pressure of 1800 lb. per sq. in. has been adopted for one industrial plant; buying habits have also changed and buying methods have improved; tendency toward unified design.

L

LOCOMOTIVE TERMINALS

Articulated Oil-Burning. Articulated Oil-Burning Locomotives, Southern Pacific Railroad.

Locomotive (Lond.), vol. 35, no. 438, Feb. 15, 1929, pp. 37–41, 5 figs. Locomotives are of Mallet articulated type with 4-8-8-2 wheel arrangement having four high-pressure cylinders, 24-in. diam., by 32-in. stroke; steam pressure 235 lb. per sq. in.; tractive effort 112,760 lb.

Diesel-Electric. New Diesel-Electric Locomotives for the Canadian National Railways. Ry. Gaz. (Lond.), vol. 50, no. 5, Feb. 1, 1929, p. 148. New type of oil-burning locomotive driven by combination of Diesel engine and electric dynamo has been introduced in Canada by Canadian National Railways; locomotive is in two units, each fitted with 12-cylinder Diesel engine 12-in. bore and 12-in. stroke; duplicate controls are provided at either end; complete engine weighs 290 tons, and is capable of hauling train of 2800 tons at average speed of 40 m.p.h.; locomotive develops 2660 hp. and ranks as largest and most powerful of its kind in world.

Feedwater Heaters. Economizers for Locomotives (Speisewasservorwaermer fuer Lokomotiven), St. Felsz. Archiv fuer Waermewirtschaft und Dampfkesselwesen (Berlin), vol. 10, no. 2, Feb. 1929, pp. 64–65. Development of feedwater devices for locomotives is briefly considered, after which results are given of numerous trial runs carried out in Poland with different types of locomotives; these indicate that exhaust steam injectors of Friedman type give better results than piston pumps and economizers.

Fort Worth, Tex. Engine Terminal and Shops, Texas and Pacific Railway. Eng. News-Rec., vol. 102, no. 11, Mar. 14, 1929, pp. 420–422, 5 figs. Fort Worth yard has mechanical plants for washing engines and boilers and getting up steam, steel repair shop or transverse type, enginehouse with 32 stalls, locomotive repair shop with 9 repair pits; fuel-oil supply for engines; track layout at yard entrance, plan of engine terminal and shops.

Geared. The Geared Steam Locomotive, K. W. Williams. Engineering (Lond.), vol. 127, no. 3289, Jan. 25, 1929, pp. 116–119, 11 figs. Advantages of geared steam locomotive are enumerated; concludes that L-shaped type, with its grate between frames, is best general form, while pressures up to 859 lb. per sq. in., efficient degree of superheat, and complete accessibility for cleaning are essentials; boiler which seems to meet these conditions has been constructed by Kerr, Stuart and Co. for pressure of 1000 lb. per sq. in.; Abstract of paper before Junior Instn. Engrs.

High-Pressure. High-Pressure Steam for Locomotives, C. S. Darling. Ry. Engr. (Lond.), vol. 50, no. 589, Feb. 1929, pp. 75–77, 4 figs. Suggestions for employment of two-stage boiler with high-pressure section supplying steam to small-diameter turbine, and normal pressure section for ordinary reciprocating engine; gain in efficiency with increase in pressure; steam consumption and coal consumption with increase in initial pressure; Borsig and Schmidt tests on high-pressure reciprocating engine; compounding by high-pressure primary engine.

Winterthur Type of High-Pressure Locomotives (Die Hochdrucklokomotive fuer 60 at Bauart Winterthur), H. Brown. V.D.I.-Zeit., Berlin), vol. 73, no. 5, Feb. 2, 1929, pp. 151–156, 23 figs. Principles of design and features of locomotive, for 60 atmos. pressure; steam-entropy diagram; thermal efficiency as function of pressure; details of boilers and three-cylinder steam engine; results of comparative tests showing 35 per cent saving in coal.

New Types. Three New Locomotives of Unusual Size and Design. Eng. News-Rec., vol. 102, no. 9, Feb. 28, 1929, pp. 351–352, 5 figs. Features of Southern Pacific new type of simple expansion articulated locomotive with 4-8-8-2 wheel arrangement, cab at front end and smokestack at rear; Northern Pacific simple Mallet 2-8-8-4 locomotive 125 ft. long and weighing 1,116,000 lb.; European locomotive using steam pressure at 853 lb. in three-cylinder uniflow engine.

2-8-8-4. Heavy 2-8-8-4 Type Locomotive for the Northern Pacific. Ry. Mech. Engr., vol. 103, no. 2, Feb. 1929, pp. 56–63, 13 figs. Locomotive weighs 1,116,000 lb.; overall length is 124 ft. 11¹/₈ in.; develops combined tractive force of 135,300 lb.; largest locomotive ever built; all four cylinders have same diameter and stroke, 26 in. by 32 in.; table of dimensions, weights and proportions; power-operated multiple throttle; to perform work of two Mikado locomotives.

LUBRICATING OILS

Airplane-Engine. Fluidity and Other Properties of Aviation-Engine Oils, E. R. Lederer and F. R. Staley. Soc. Automotive Engrs.—Jl., vol. 24, no. 2, Feb. 1929, pp. 149–154, 9 figs. Selection of proper crude important; dewaxing and fractionating of lubricating oils has restricted in improvement in quality and in unrestricted use as all-weather aircraft oils; fluidity or consistency of aviation-engine oils below their A.S.T.M. pour-points and significance of dewaxing paraffin-bearing oils; fluidity machine and test results; oil consumption; stability of oil in service; other methods of testing.

Automotive. Forty Below Zero Chilling Produces Oil Viscous when Hot, Fluid When Cold, P. Truesdell and M. B. Miller. Nat. Petroleum News, vol. 21, nos. 4–5, Jan. 23 and 30, 1929, pp. 27–28 and 69, 70 and 72, 1 fig. Jan. 23: Oil for hard-driven cars must stand up under heat, but must be fluid at low temperature to permit engine to start on cold morning; work by M. B. Miller in operation of Sharples centrifugal dewaxing process makes this possible. Jan. 30: Detailed description of refrigerating process, quoted from Miller; to convert average Sharples dewaxing plant would cost bout $10,000 per 100 bbl. of finished oil capacity.

Steam-Turbine. Conditions for Lubricating Oils for Steam Turbines, Staeger. Brown Boveri Rev. (Baden, Switzerland), vol. 16, no. 2, Feb. 1929, pp. 92–97, 5 figs. Result of large-scale service tests, extending over several years, carried out on various turbines by Verein Deutscher Eisenhuettenleute in cooperation with Vereinigung Deutscher Elektrizitaetswerke; Brown Boverei tests regarding aging of oil; regulations for testing lubricating oils for turbines, based on results of experiments; greatest value on artificial aging test

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MACHINE TOOLS

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Bases, Arc Welded, Design of. Designing Arc-Welded Machine Bases, J. L. Brown. Machy. (N. Y.), vol. 35, no. 7, Mar. 1929, pp. 504–507, 14 figs. Suggested methods of design of machine bases made from arc-welded structural steel shapes and piping; many advantages which these machinery base structures have over cast-iron types they are displacing, and even over other types of steel section bedplates.

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MALLEABLE IRON

Castings, Heat Treatment of. The Heat Treatment of Malleable Cast Iron, H. A. Schwartz. Fuels and Furnaces, vol. 7, no. 2, Feb. 1929, pp. 187–191. Maximum temperature in heat treating malleable castings should be as high as possible consistent with economical transmission of heat, maintenance of furnaces, deformation of castings under their own weight at high temperatures, and fusibility of any packing used to prevent such deformation.

Melting. Duplex Plan Reduces Melting Time, B. Finney. Iron Age, vol. 123, no. 6, Feb. 7, 1929, pp. 397–399, 3 figs. Duplex melting system employed in malleable iron foundry of Southern Malleable Iron Co., East St. Louis, Ill., is described; output of molten metal doubled without increasing size of furnace; cupola supplements air furnace; novel method of removing slag by steam jet; cupola charged like blast furnace.

MAGNESIUM ALLOYS

Castings. Magnesium Alloy Castings, Player. Metallurgist (Supp. to Engineer, Lond.), Jan. 25, 1929, pp. 15–16. Notes on production and properties of these materials; data put forward go to prove that production of magnesium alloys in all forms is now on strictly commercial scale of quantity, technical excellence, and cost, thus offering engineer new material possessing many desirable qualities. Abstract of paper read at joint meeting of Birmingham Met. Soc., Staffordshire Iron and Steel Inst., and Birmingham Local Sec., Inst. of Metals.

METALS

High Steam Pressures and Temperatures. New Metals Now Used for Modern High Pressures and Temperatures, A. E. White. Power, vol. 69, no. 8, Feb. 19, 1929, pp. 330–332. Power plants are now in state of transition to use of special metals and alloys such as experienced by machine and automotive field some years ago; use of cast iron decreasing rapidly; how alloy steels are used; stainless steel used for turbine blades; use of welding in powerplant construction is receiving increased attention; magnetic testing for detecting flaws in metals. Abstract of paper presented before Midwest Power Eng. Conference.

Molten, Properties of. Properties of Molten Metals and Alloys and Their Significance for Casting Process (Die Eigenschaften der schmelzfluessigen Metalle und Legierungen und ihre Bedeutung fuer den Gussvorgang), F. Sauerwald. Giesserei (Duesseldorf), vol. 16, no. 3, Jan. 18, 1929, pp. 49–55, 12 figs. Measurement of physical properties of molten metals and results; direct influence of physical properties on casting process; molecular constitution of molten metals and their importance in foundry practice.

MILLING MACHINES

Hydraulic Feed. Performance Records of Hydraulic-Feed Milling Machines, F. B. Heitkamp. Am. Mach., vol. 70, no. 9, Feb. 28, 1929, pp. 347–351, 10 figs. Description of eight operations, most of them from automobile shops, show what can be done with milling machine equipped with hydraulic feed; performance figures on Hydromatic machine of Cincinnati Milling Machine Co. with locked hydraulic feed.

N

NITRIDATION

Practice in. Surface Hardening by the Nitriding Process, H. W. McQuaid. Am. Mach., vol. 70, no. 9, Feb. 28, 1929, pp. 360–362, 2 figs. Operating practice as worked out by Timken-Detroit Axle Co., which has reduced time of nitriding below that of common practice, is described; nitriding process relatively simple when compared with carburizing and hardening operations required to obtain good case-hardened work.

O

OIL ENGINES

Airless-Injection, Fuel Pumps for. Solid Injection Fuel Pumps—and How to Adjust Them, H. F. Shepherd. Power, vol. 69, no. 8, Feb. 18, 1929, pp. 309–311, 2 figs. High oil pressures carried by solid-injection engines make pump design radically different from that of pumps on other oil engines; starting and stopping engine; design of relief valve.

OPEN-HEARTH FURNACES

Basic. Basic Open-Hearth Yields, C. D. King. Am. Inst. Min. and Met. Engrs.—Tech. Pub., no. 186, Feb. 1929, 38 pp. Also abstract in Iron Age, vol. 123, no. 9, Feb. 28, 1929, pp. 596–598, 1 fig. Discussion of yields, with reference to ingot yields obtained in process of converting pig iron, scrap, and ore to steel; in conversion, some scrap is produced; to ascertain cause of many possible losses, it is necessary occasionally to conduct carefully controlled heat tests; lower yield with higher ore and pig charges does not necessarily mean higher ingot cost in actual prac-

tice, since inexpensive iron in ore may offset disadvantage of lower yield.

Design. Possibilities of Improving the Heat Economy of Open-Hearth Furnaces (Mojligheter till forbattring av martinugnens varmeekonomi), M. Tigerschiold. Jernkontorets Annaler (Stockholm), vol. 111, June 2, 1928, pp. 71–103, 23 figs. History of open-hearth furnaces; results obtained from three basic open-hearth furnaces in generation of gases when fired with wood or coal; detailed of closed insulated regenerators; improved burners; water-cooled gas and air intakes; utilization of heat of exhaust gases.

OXYACETYLENE WELDING

Machine. Oxy-Acetylene Welding by Machine, J. K. Anderson. Iron Age, vol. 123, no. 9, Feb. 28, 1929, pp. 591–595, 9 figs. Recent developments in oxyacetylene welding have extended scope to 8-in. pipe, to flat sheet metal, and to joints in steel plate up to $^3/_8$ in. thick; outline of steps in development; requisites of successful welding on sheet steel products; automatic welding of plates. Abstracted from paper presented before Int. Acetylene Assn.

P

PENSTOCKS

Construction. Handling Penstock Pipe on Buck's Creek Project, D. McFarland. Eng. News-Rec., vol. 102, no. 9, Feb. 28, 1929, p. 357, 2 figs. Double tram line brought pipe from bottom of mountain, and special derrick with hinged bottom adjustable for varying slope of penstock was used to place pipe.

PIPE, CAST IRON

Centrifugal Casting. The Centrifugal Casting of Iron Pipes, E. J. Fox and P. H. Wilson. Iron and Steel Industry (Lond.), vol. 2, no. 5, Feb. 1929, pp. 147–150, 6 figs. Survey of centrifugal casting of iron pipes; spinning of pipe; annealing operations; speed of rotation of mold; rate of flow of metal and rate of traverse; synchronizing operations; casting temperature; metal composition; production of chill; microstructure; metal composition of chill; microstructure; normalizing; mechanical tests; data on materials used. Abstract of paper read before Coordinating Societies at Birmingham.

POWER GENERATION

Seawater. Power From Warm Water. Engineer (Lond.), vol. 147, no. 3811, Jan. 25, 1929, p. 111. Particulars of 50-kw. unit tested at Ougrée-Marihaye Steel Co.'s works in Belgium based on Claude's scheme for developing power by taking advantage of difference in temperature between surface and depths of water in tropical seas; turbine is single-stage machine governed by admission of air on exhaust side; no information is as to source of heat which produced working vapor at temperature of 96.4 deg. fahr.

POWER PLANTS, DIESEL-ELECTRIC

Operating Costs. A Survey of Diesel Operating Costs by Two Authorities, J. Kuttner. Oil Engine Power, vol. 7, no. 2, Feb. 1929, pp. 94–97, 3 figs. Diesel-engine operating costs given in 1927–1928 Serial Report of Power Committee of National Electric Light Assn. compared with Diesel-engine operating costs investigated by British Diesel Engine Users Assn.; fuel consumption, lubricating-oil consumption, labor costs, consumable supplies and repairs for five plants, shown; differences in load factors shown by two reports.

POWER PLANTS, HYDROELECTRIC

Pumped-Storage. Pumped-Storage Hydro-Electric Plants—A New Use for Diesel Power. Oil Engine Power, vol. 7, no. 2, Feb. 1929, pp. 98–99, 1 fig. Use of Diesel engines in hydroelectric plants for operating centrifugal pump for pumping water backwards from tailrace to head-race and thus increasing peak-load capacity, is discussed.

POWER PLANTS, STEAM

[See STEAM-ELECTRIC POWER PLANTS; STEAM POWER PLANTS.]

PRESSES

Hydraulic. Modern Methods of Charging Hydraulic Extrussion Preises Metal Industry (Lond.), vol. 34, no. 6, Feb. 8, 1929, pp. 143–145, 7 figs. Output of hydraulic extrusion press depends upon way in which it is charged with billets of metals to be extruded; more modern presses are constructed so that billet is introduced from rear, i.e., between container and plunger, and can be slid into container, pierced, and extruded by single stroke of ram.

PUMPS

Submerged-Motor. Motor and Pump Made Two-in-one Features of New Motor Pump. Hydraulic Eng., vol. 5, no. 2, Feb. 1929, pp. 34–35, 2 figs. Design of new pump of Submersible Motorpump Co.; manufactured at present in sizes for from 10- to 30-in. wells and with motors of from 5 to 150 hp. with any practical number of stages; problem of keeping water from active parts of motor claimed to be solved.

PUMPS, CENTRIFUGAL

Design. Present Status of Centrifugal Pump Design (Der gegenwaertige Stand des Kriesel pumpenbaues), C. Pfleiderer. V.D.I.-Zeit. (Berlin), vol. 73, no. 6, Feb. 9, 1929, pp. 177–187, 35 figs. Features of special heavy-duty, low-head pumps utilizing principle of Francis runner or of propeller; axial pumps by Maffei-Schwartzkopf; special multi-stage high-head (up to 2300 m.), high speed (up to 4520 r.p.m.) pumps for boilers, hydraulic machinery, water works, chemical plants, fire departments, etc.; centrifugal pumps made of special vitrified clay proposed by Deutsche Ton- und Steinzeug Industrie A.-G.

R

REFRIGERATION

CO_2 Production and Uses. Production and Industrial Uses of Solid Carbon-Dioxide (Herstellung und Industrielle Verwertung fester Kohlensaeure), R. Plank. V.D.I.-Zeit. (Berlin), vol. 73, no. 7, Feb. 16, 1929, pp. 221–224, 2 figs. Notes surprising development of industry in United States; properties of dry ice, production of pure carbon dioxide, its solidification; temperature-entropy diagram of carbon dioxide; dry ice as refrigerant; prospects of dry-ice industry.

Recent Developments. Recent Developments in Refrigeration, B. L. Rathmall. Ice and Cold Storage (Lond.), vol. 32, no. 372, Mar. 1929, pp. 57–61, and (discussion) 61–62, 9 figs. Recent developments in refrigeration referred to are improved compressor design; ported compressors for dealing with suction gases at several pressures; clearance pockets; higher piston speeds; use of precooling by primary evaporation and multiple-effect compression for marine work; new types of condensers and evaporators; refrigeration in trawlers. Abstract of paper read before Brit. Assn. of Refrig.

ROLLING MILLS

Cold-Rolling. Modern Cold-Rolling Plants. Demag News (Duisburg), vol. 3, no. 1, Jan. 1929, pp. 1–12, 30 figs. Cold rolling of iron and steel described; methods of removing ferric-oxide scale in buckling mill and by pickling; smaller size of standard cold rolling mill; precision adjusting gear; transmission gear driving rolling mills; influence of diameter of rolls upon reduction of thickness; three-high mills; four-roll mills; reversing mills; trimming; annealing practice.

Design. The Rolling Mill of the Future, W. J. Pettis. Metal Industry (N. Y.), vol. 27, no. 1, Jan. 1929, pp. 4–5. Author predicts that in future there will be no brass-mill casting shop; refinements in mechanical construction of rolls; newest rolls either cluster type, or four-high stands, are mounted on roller bearings and set of rolls with crushing power of tons, can be turned over by hand when idle.

Practice, United States. Four-High and Six-High Rolling Mills in United States (Vierund Sechswalzengerueste in Amerikanischen Walzwerken), E. Link. Stahl und Eisen (Duesseldorf), vol. 49, no. 2, Jan. 10, 1929, pp. 37–40, 4 figs. Notes on use of roller bearings and arrangement of rolls in four- and six-high mills; utilization of springs of rolls in place of calibration; description of continuous sheet mills of Weirton Steel Co.

S

STEAM ACCUMULATORS

Sack-Kiesselbach. Results Obtained With Sack and Kiesselbach Steam Accumulator Installed at Differdange (Résultats obtenus avec l'accumulateur de vapeur "Sack et Kiesselbach" Installé a Differdange). Chaleur et Industrie (Paris), vol. 9, no. 103, Nov. 1928, pp. 716–722, 5 figs. Description of installation which is composed of following parts: accumulator itself, hot-water circulating pump, return pipe, compensation pipe and feed regulator.

STEAM ENGINES

Reciprocating, Heat Transmission. The Transfer of Heat in Reciprocating Engines, A. Naegel. Engineering (Lond.), vol. 127, no. 3291, Feb. 8, 1929, pp. 170–182, 13 figs. Review of work of M. J. Nadal and Duchesne, E. Heinrich, and W. Nusselt, on investigation of heat transfer in steam engines; question of heat transfer in internal-combustion engines.

STEAM-ELECTRIC POWER PLANTS

Baltimore, Md. Baltimore's Newest Power Plant, R. W. Edmonds. Mfrs. Rec. vol. 95, no. 9, Feb. 28, 1929, pp. 60–62, 2 figs. Two units of 48,000 hp. each in service out of ultimate installation of four units with total generating capacity of 192,000 hp.; entirely automatic in operation, representing latest in steam-power design and equipment; one boiler alone operating at capacity consumes 576 tons of coal in 24 hr., producing 12,480,000 lb. of steam.

Holland, N. J. The Holland Station of the Pennsylvania-New Jersey Power System, E. M. Gilbert. Gen. Elec. Rev., vol. 32, no. 2, Feb. 1929, pp. 95–102, 8 figs. Also Power Plant Eng., vol. 33, no. 5, Mar. 1, 1929, pp. 282–287, 5 figs. First 1200-lb. steam pressure station designed for variable-load operation; new station of 220,000-kw. ultimate capacity, with initial unit of 55,000-kw. capacity, is being constructed at Holland, N. J., on Delaware River; details of turbo-generator unit, high-pressure boiler, fuel pulverizing and burning equipment, condenser, etc.

Kalamazoo, Mich. Operating Experiences with Pulverized Coal at Kalamazoo, J. W. Mackenzie and R. G. Paddock. Power Plant Eng., vol. 33, no. 4, Feb. 15, 1929, pp. 234–238, 7 figs. Kalamazoo steam plant of Consumers Power Co. is described; construction of furnaces; coal pulverizing equipment; mills are driven by 440-volt constant-speed a.c. motors at 1150 r.p.m.; manifold and burner arrangements; regulation of pulverized fineness; experiments with exhaust fan blades and mill hammers; changes in burners improved combustion; mill drying eliminated clogging.

Kansas City. 1200-Lb. Pressure—A Dollar Saver, E. Jowett. Power, vol. 69, no. 8, Feb. 19, 1929, pp. 326–329, 3 figs. See also Power Plant Eng., vol. 33, no. 4, Feb. 15, 1929, pp. 259–260. Kansas City Power and Light Co. has installed at its Northeast Station high-pressure equipment consisting of 10,000-kw., 80 per cent power-factor turbine generator and two 17,000-sq. ft. boilers with reheaters, fired by pulverized coal; analysis of system load and proposed equipment; turbine generator has unusual features. Abstract of paper presented before Midwest Power Eng. Conference.

STEAM PIPE LINES

Insulation. Heat Insulation of Steam Piping and Other Hot Surfaces, C. L. Hubbard. South. Power Jl., vol. 47, no. 2, Feb. 1929, pp. 97–108, 29 figs. High pressures and high temperatures in steam plants, with resultant increase in magnitude of possible radiation losses, emphasize necessity of adequate heat insulation; long-distance transmission of steam; insulating materials commonly used include asbestos, carbonate of magnesia, diatomaceous earth, cork and mineral wool; pipe protection; insulation of fittings; block and sheet covering; underground insulation; heat loss from bare pipes.

STEAM POWER PLANTS

High-Pressure. Generation and Utilization of High Pressure Steam in the Florisdorf Loeffler Plant (Erzeugung und Verwertung von Hoechstdruckdampf. Die Floridsdorfer Loeffler-Anlage), A. Demmer. Zeit. des Oesterreichischen Ingenieur und Architekten Vereines (Vienna), vol. 81, no. $^3/_4$, Jan. 18, 1929, pp. 19–23, 9 figs. Merits of Loeffler high-pressure process; details of boilers, economics of generating steam of 140 atmos. pressure, 480 deg. cent. at rate of 12 tons; high-pressure steam power plants.

Industrial. Progress in the Art of Steam Generator Grows Out of Operating Experience at Staley Plant, G. F. Klein. Power, vol. 69, no. 11, Mar. 12, 1929, pp. 424–428, 5 figs. Account of gradual additions and improvements to steam generating equipment at Decatur, Ill., plant of large manufacturer of corn products; recently it was decided to install three more large pulverized-fuel units and convert to pulverized coal present two 8970-sq. ft. stoker-fired boilers; at 400 per cent of normal rating boiler is designed to deliver continuously 100,000 lb. of steam per hour; burner and mill arrangement was designed so that unit of each type could be used under same boiler and at same time.

Wage-Payment Plans. Increased Efficiency Meets the Pay-Roll, M. J. Hess. Factory and Indus. Mgmt., vol. 17, no. 2, Feb. 1929, pp. 264–

Locomotive (Lond.), vol. 35, no. 438, Feb. 15, 1929, pp. 37–41, 5 figs. Locomotives are of Mallet articulated type with 4-8-8-2 wheel arrangement having four high-pressure cylinders, 24-in. diam., by 32-in. stroke; steam pressure 235 lb. per sq. in.; tractive effort 112,760 lb.

Diesel-Electric. New Diesel-Electric Locomotives for the Canadian National Railways. Ry. Gaz. (Lond.), vol. 50, no. 5, Feb. 1, 1929, p. 148. New type of oil-burning locomotive driven by combination of Diesel engine and electric dynamo has been introduced in Canada by Canadian National Railways; locomotive is in two units, each fitted with 12-cylinder Diesel engine 12-in. bore and 12-in. stroke; duplicate controls are provided at either end; complete engine weighs 290 tons, and is capable of hauling train of 2800 tons at average speed of 40 m.p.h.; locomotive develops 2660 hp. and ranks as largest and most powerful of its kind in world.

Feedwater Heaters. Economizers for Locomotives (Speisewasservorwaermer fuer Lokomotiven), St. Felsz. Archiv fuer Waermewirtschaft und Dampfkesselwesen (Berlin), vol. 10, no. 2, Feb. 1929, pp. 64–65. Development of feedwater devices for locomotives is briefly considered, after which results are given of numerous trial runs carried out in Poland with different types of locomotives; these indicate that exhaust steam injectors of Friedman type give better results than piston pumps and economizers.

Fort Worth, Tex. Engine Terminal and Shops, Texas and Pacific Railway. Eng. News-Rec., vol. 102, no. 11, Mar. 14, 1929, pp. 420–422, 5 figs. Fort Worth yard has mechanical plants for washing engines and boilers and getting up steam, steel repair shop or transverse type, enginehouse with 32 stalls, locomotive repair shop with 9 repair pits; fuel-oil supply for engines; track layout at yard entrance, plan of engine terminal and shops.

Geared. The Geared Steam Locomotive, K. W. Williams. Engineering (Lond.), vol. 127, no. 3289, Jan. 25, 1929, pp. 116–119, 11 figs. Advantages of geared steam locomotive are enumerated; concludes that L-shaped type, with its grate between frames, is best general form, while pressures up to 859 lb. per sq. in., efficient degree of superheat, and complete accessibility for cleaning are essentials; boiler which seems to meet these conditions has been constructed by Kerr, Stuart and Co. for pressure of 1000 lb. per sq. in.; Abstract of paper before Junior Instn. Engrs.

High-Pressure. High-Pressure Steam for Locomotives, C. S. Darling. Ry. Engr. (Lond.), vol. 50, no. 589, Feb. 1929, pp. 75–77, 4 figs. Suggestions for employment of two-stage boiler with high-pressure section supplying steam to small-diameter turbine, and normal pressure section for ordinary reciprocating engine; gain in efficiency with increase in pressure; steam consumption and coal consumption with increase in initial pressure; Borsig and Schmidt tests on high-pressure reciprocating engine; compounding by high-pressure primary engine.

Winterthur Type of High-Pressure Locomotives (Die Hochdrucklokomotive fuer 60 at Bauart Winterthur), H. Brown. V.D.I.-Zeit., Berlin), vol. 73, no. 5, Feb. 2, 1929, pp. 151–156, 23 figs. Principles of design and features of locomotive, for 60 atmos. pressure; steam-entropy diagram; thermal efficiency as function of pressure; details of boilers and three-cylinder steam engine; results of comparative tests showing 35 per cent saving in coal.

New Types. Three New Locomotives of Unusual Size and Design. Eng. News-Rec., vol. 102, no. 9, Feb. 28, 1929, pp. 351–352, 5 figs. Features of Southern Pacific new type of simple expansion articulated locomotive with 4-8-8-2 wheel arrangement, cab at front end and smokestack at rear; Northern Pacific simple Mallet 2-8-8-4 locomotive 125 ft. long and weighing 1,116,000 lb.; European locomotive using steam pressure at 853 lb. in three-cylinder uniflow engine.

2-8-8-4. Heavy 2-8-8-4 Type Locomotive for the Northern Pacific. Ry. Mech. Engr., vol. 103, no. 2, Feb. 1929, pp. 56–63, 13 figs. Locomotive weighs 1,116,000 lb.; overall length is 124 ft. 11$^{5}/_{8}$ in.; develops combined tractive force of 135,300 lb.; largest locomotive ever built; all four cylinders have same diameter and stroke, 26 in. by 32 in.; table of dimensions, weights and proportions; power-operated multiple throttle; to perform work of two Mikado locomotives.

LUBRICATING OILS

Airplane-Engine. Fluidity and Other Properties of Aviation-Engine Oils, E. R. Lederer and F. R. Staley. Soc. Automotive Engrs.—Jl., vol. 24, no. 2, Feb. 1929, pp. 149–154, 9 figs. Selection of proper crude important; dewaxing and fractionating of lubricating oils has restricted in improvement in quality and in unrestricted use as all-weather aircraft oils; fluidity or consistency of aviation-engine oils below their A.S.T.M. pour-points and significance of dewaxing paraffin-bearing oils; fluidity machine and test results; oil consumption; stability of oil in service; other methods of testing.

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Castings. Magnesium Alloy Castings, Player. Metallurgist (Supp. to Engineer, Lond.), Jan. 25, 1929, pp. 15–16. Notes on production and properties of these materials; data put forward go to prove that production of magnesium alloys in all forms is now on strictly commercial scale of quantity, technical excellence, and cost, thus offering engineer new material possessing many desirable qualities. Abstract of paper read at joint meeting of Birmingham Met. Soc., Staffordshire Iron and Steel Inst., and Birmingham Local Sec., Inst. of Metals.

METALS

High Steam Pressures and Temperatures. New Metals Now Used for Modern High Pressures and Temperatures, A. E. White. Power, vol. 69, no. 8, Feb. 19, 1929, pp. 330–332. Power plants are now in state of transition to use of special metals and alloys such as experienced by machine and automotive field some years ago, use of cast iron decreasing rapidly; how alloy steels are used; stainless steel used for turbine blades; use of welding in powerplant construction is receiving increased attention; magnetic testing for detecting flaws in metals. Abstract of paper presented before Midwest Power Eng. Conference.

Molten, Properties of. Properties of Molten Metals and Alloys and Their Significance for Casting Process (Die Eigenschaften der schmelzfluessigen Metalle und Legierungen und ihre Bedeutung fuer den Gussvorgang), F. Sauerwald. Giesserei (Duesseldorf), vol. 16, no. 3, Jan. 18, 1929, pp. 49–55, 12 figs. Measurement of physical properties of molten metals and results; direct influence of physical properties on casting process; molecular constitution of molten metals and their importance in foundry practice.

MILLING MACHINES

Hydraulic Feed. Performance Records of Hydraulic-Feed Milling Machines, F. B. Heitkamp. Am. Mach., vol. 70, no. 9, Feb. 28, 1929, pp. 347–351, 10 figs. Description of eight operations, most of them from automobile shops, show what can be done with milling machine equipped with hydraulic feed; performance figures on Hydromatic machine of Cincinnati Milling Machine Co. with locked hydraulic feed.

N

NITRIDATION

Practice in. Surface Hardening by the Nitriding Process, H. W. McQuaid. Am. Mach., vol. 70, no. 9, Feb. 28, 1929, pp. 360–362, 2 figs. Operating practice as worked out by Timken-Detroit Axle Co., which has reduced time of nitriding below that of common practice, is described; nitriding process relatively simple when compared with carburizing and hardening operations required to obtain good case-hardened work.

O

OIL ENGINES

Airless-Injection, Fuel Pumps for. Solid Injection Fuel Pumps—and How to Adjust Them, H. F. Shepherd. Power, vol. 69, no. 8, Feb. 18, 1929, pp. 309–311, 2 figs. High oil pressures carried by solid-injection engines make pump design radically different from that of pumps on other oil engines; starting and stopping engine; design of relief valve.

OPEN-HEARTH FURNACES

Basic. Basic Open-Hearth Yields, C. D. King. Am. Inst. Min. and Met. Engrs.—Tech. Pub., no. 186, Feb. 1929, 38 pp. Also abstract in Iron Age, vol. 123, no. 9, Feb. 28, 1929, pp. 596–598, 1 fig. Discussion of yields, with reference to ingot yields obtained in process of converting pig iron, scrap, and ore to steel; in conversion, some scrap is produced; to ascertain cause of many possible losses, it is necessary occasionally to conduct carefully controlled heat tests; lower yield with higher ore and pig charges does not necessarily mean higher ingot cost in actual prac-

tice, since inexpensive iron in ore may offset disadvantage of lower yield.

Design. Possibilities of Improving the Heat Economy of Open-Hearth Furnaces (Mojligheter till forbattring av martinugnens varmeekonomi), M. Tigerschiold. Jernkontorets Annaler (Stockholm), vol. 111, June 2, 1928, pp. 71–103, 23 figs. History of open-hearth furnaces; results obtained from three basic open-hearth furnaces in generation of gases when fired with wood or coal; detailed of closed insulated regenerators; improved burners; water-cooled gas and air intakes; utilization of heat of exhaust gases.

OXYACETYLENE WELDING

Machine. Oxy-Acetylene Welding by Machine, J. K. Anderson. Iron Age, vol. 123, no. 9, Feb. 28, 1929, pp. 591–595, 9 figs. Recent developments in oxyacetylene welding have extended scope to 8-in. pipe, to flat sheet metal, and to joints in steel plate up to $^3/_8$ in. thick; outline of steps in development; requisites of successful welding on sheet steel products; automatic welding of plates. Abstracted from paper presented before Int. Acetylene Assn.

P

PENSTOCKS

Construction. Handling Penstock Pipe on Buck's Creek Project, D. McFarland. Eng. News-Rec., vol. 102, no. 9, Feb. 28, 1929, p. 357, 2 figs. Double tram line brought pipe from bottom of mountain, and special derrick with hinged bottom adjustable for varying slope of penstock was used to place pipe.

PIPE, CAST IRON

Centrifugal Casting. The Centrifugal Casting of Iron Pipes, E. J. Fox and P. H. Wilson. Iron and Steel Industry (Lond.), vol. 2, no. 5, Feb. 1929, pp. 147–150, 6 figs. Survey of centrifugal casting of iron pipes; spinning of pipe; annealing operations; speed of rotation of mold; rate of flow of metal and rate of traverse; synchronizing operations; casting temperature; metal composition; production of chill; microstructure; metal composition of chill; microstructure; normalizing; mechanical tests; data on materials used. Abstract of paper read before Coordinating Societies at Birmingham.

POWER GENERATION

Seawater. Power From Warm Water. Engineer (Lond.), vol. 147, no. 3811, Jan. 25, 1929, p. 111. Particulars of 50-kw. unit tested at Ougrée-Marihaye Steel Co.'s works in Belgium based on Claude's scheme for developing power by taking advantage of difference in temperature between surface and depths of water in tropical seas; turbine is single-stage machine governed by admission of air on exhaust side; no information is as to source of heat which produced working vapor at temperature of 96.4 deg. fahr.

POWER PLANTS, DIESEL-ELECTRIC

Operating Costs. A Survey of Diesel Operating Costs by Two Authorities, J. Kuttner. Oil Engine Power, vol. 7, no. 2, Feb. 1929, pp. 94–97, 3 figs. Diesel-engine operating costs given in 1927–1928 Serial Report of Power Committee of National Electric Light Assn. compared with Diesel-engine operating costs investigated by British Diesel Engine Users Assn.; fuel consumption, lubricating-oil consumption, labor costs, consumable supplies and repairs for five plants, shown; differences in load factors shown by two reports.

POWER PLANTS, HYDROELECTRIC

Pumped-Storage. Pumped-Storage Hydro-Electric Plants—A New Use for Diesel Power. Oil Engine Power, vol. 7, no. 2, Feb. 1929, pp. 98–99, 1 fig. Use of Diesel engines in hydro-electric plants for operating centrifugal pump for pumping water backwards from tailrace to head-race and thus increasing peak-load capacity, is discussed.

POWER PLANTS, STEAM

[See STEAM-ELECTRIC POWER PLANTS; STEAM POWER PLANTS.]

PRESSES

Hydraulic. Modern Methods of Charging Hydraulic Extrussion Preises Metal Industry (Lond.), vol. 34, no. 6, Feb. 8, 1929, pp. 143–145, 7 figs. Output of hydraulic extrusion press depends upon way in which it is charged with billets of metals to be extruded; more modern presses are constructed so that billet is introduced from rear, i.e., between container and plunger, and can be slid into container, pierced, and extruded by single stroke of ram.

PUMPS

Submerged-Motor. Motor and Pump Made Two-in-one Features of New Motor Pump. Hydraulic Eng., vol. 5, no. 2, Feb. 1929, pp. 34–35, 2 figs. Design of new pump of Submersible Motorpump Co.; manufactured at present in sizes for from 10- to 30-in. wells and with motors of from 5 to 150 hp. with any practical number of stages; problem of keeping water from active parts of motor claimed to be solved.

PUMPS, CENTRIFUGAL

Design. Present Status of Centrifugal Pump Design (Der gegenwaertige Stand des Kriesel pumpenbaues), C. Pfleiderer. V.D.I.-Zeit. (Berlin), vol. 73, no. 6, Feb. 9, 1929, pp. 177–187, 35 figs. Features of special heavy-duty, low-head pumps utilizing principle of Francis runner or of propeller; axial pumps by Maffei-Schwartzkopf; special multi-stage high-head (up to 2300 m.), high speed (up to 4520 r.p.m.) pumps for boilers, hydraulic machinery, water works, chemical plants, fire departments, etc.; centrifugal pumps made of special vitrified clay proposed by Deutsche Ton- und Steinzeug Industrie A.-G.

R

REFRIGERATION

CO_2 Production and Uses. Production and Industrial Uses of Solid Carbon-Dioxide (Herstellung und Industrielle Verwertung fester Kohlensaeure), R. Plank. V.D.I.-Zeit. (Berlin), vol. 73, no. 7, Feb. 16, 1929, pp. 221–224, 2 figs. Notes surprising development of industry in United States; properties of dry ice, production of pure carbon dioxide, its solidification; temperature-entropy diagram of carbon dioxide; dry ice as refrigerant; prospects of dry-ice industry.

Recent Developments. Recent Developments in Refrigeration, B. L. Rathmall. Ice and Cold Storage (Lond.), vol. 32, no. 372, Mar. 1929, pp. 57–61, and (discussion) 61–62, 9 figs. Recent developments in refrigeration referred to are improved compressor design; ported compressors for dealing with suction gases at several pressures; clearance pockets; higher piston speeds; use of precooling by primary evaporation and multiple-effect compression for marine work; new types of condensers and evaporators; refrigeration in trawlers. Abstract of paper read before Brit. Assn. of Refrig.

ROLLING MILLS

Cold-Rolling. Modern Cold-Rolling Plants. Demag News (Duisburg), vol. 3, no. 1, Jan. 1929, pp. 1–12, 30 figs. Cold rolling of iron and steel described; methods of removing ferric-oxide scale in buckling mill and by pickling; smaller size of standard cold rolling mill; precision adjusting gear; transmission gear driving rolling mills; influence of diameter of rolls upon reduction of thickness; three-high mills; four-roll mills; reversing mills; trimming; annealing practice.

Design. The Rolling Mill of the Future, W. J. Pettis. Metal Industry (N. Y.), vol. 27, no. 1, Jan. 1929, pp. 4–5. Author predicts that in future there will be no brass-mill casting shop; refinements in mechanical construction of rolls; newest rolls either cluster type, or four-high stands, are mounted on roller bearings and set of rolls with crushing power of tons, can be turned over by hand when idle.

Practice, United States. Four-High and Six-High Rolling Mills in United States (Vierund Sechswalzengerueste in Amerikanischen Walzwerken), E. Link. Stahl und Eisen (Duesseldorf), vol. 49, no. 2, Jan. 10, 1929, pp. 37–40, 4 figs. Notes on use of roller bearings and arrangement of rolls in four- and six-high mills; utilization of springs of rolls in place of calibration; description of continuous sheet mills of Weirton Steel Co.

S

STEAM ACCUMULATORS

Sack-Kiesselbach. Results Obtained With Sack and Kiesselbach Steam Accumulator Installed at Differdange (Résultats obtenus avec l'accumulateur de vapeur "Sack et Kiesselbach" Installé a Differdange). Chaleur et Industrie (Paris), vol. 9, no. 103, Nov. 1928, pp. 716–722, 5 figs. Description of installation which is composed of following parts: accumulator itself, hot-water circulating pump, return pipe, compensation pipe and feed regulator.

STEAM ENGINES

Reciprocating, Heat Transmission in. The Transfer of Heat in Reciprocating Engines, A. Naegel. Engineering (Lond.), vol. 127, no. 3291, Feb. 8, 1929, pp. 170–182, 13 figs. Review of work of M. J. Nadal and Duchesne, E. Heinrich, and W. Nusselt, on investigation of heat transfer in steam engines; question of heat transfer in internal-combustion engines.

STEAM-ELECTRIC POWER PLANTS

Baltimore, Md. Baltimore's Newest Power Plant, R. W. Edmonds. Mfrs. Rec. vol. 95, no. 9, Feb. 28, 1929, pp. 60–62, 2 figs. Two units of 48,000 hp. each in service out of ultimate installation of four units with total generating capacity of 192,000 hp.; entirely automatic in operation, representing latest in steam-power design and equipment; one boiler alone operating at capacity consumes 576 tons of coal in 24 hr., producing 12,480,000 lb. of steam.

Holland, N. J. The Holland Station of the Pennsylvania-New Jersey Power System, E. M. Gilbert. Gen. Elec. Rev., vol. 32, no. 2, Feb. 1929, pp. 95–102, 8 figs. Also Power Plant Eng., vol. 33, no. 5, Mar. 1, 1929, pp. 282–287, 5 figs. First 1200-lb. steam pressure station designed for variable-load operation; new station of 220,000-kw. ultimate capacity, with initial unit of 55,000-kw. capacity, is being constructed at Holland, N. J., on Delaware River; details of turbo-generator unit, high-pressure boiler, fuel pulverizing and burning equipment, condenser, etc.

Kalamazoo, Mich. Operating Experiences with Pulverized Coal at Kalamazoo, J. W. Mackenzie and R. G. Paddock. Power Plant Eng., vol. 33, no. 4, Feb. 15, 1929, pp. 234–238, 7 figs. Kalamazoo steam plant of Consumers Power Co. is described; construction of furnaces; coal pulverizing equipment; mills are driven by 440-volt constant-speed a.c. motors at 1150 r.p.m.; manifold and burner arrangements; regulation of pulverized fineness; experiments with exhaust fan blades and mill hammers; changes in burners improved combustion; mill drying eliminated clogging.

Kansas City. 1200-Lb. Pressure—A Dollar Saver, E. Jowett. Power, vol. 69, no. 8, Feb. 19, 1929, pp. 326–329, 3 figs. See also Power Plant Eng., vol. 33, no. 4, Feb. 15, 1929, pp. 259–260. Kansas City Power and Light Co. has installed at its Northeast Station high-pressure equipment consisting of 10,000-kw., 80 per cent power-factor turbine generator and two 17,000-sq. ft. boilers with reheaters, fired by pulverized coal; analysis of system load and proposed equipment; turbine generator has unusual features. Abstract of paper presented before Midwest Power Eng. Conference.

STEAM PIPE LINES

Insulation. Heat Insulation of Steam Piping and Other Hot Surfaces, C. L. Hubbard. South. Power Jl., vol. 47, no. 2, Feb. 1929, pp. 97–108, 29 figs. High pressures and high temperatures in steam plants, with resultant increase in magnitude of possible radiation losses, emphasize necessity of adequate heat insulation; long-distance transmission of steam; insulating materials commonly used include asbestos, carbonate of magnesia, diatomaceous earth, cork and mineral wool; pipe protection; insulation of fittings; block and sheet covering; underground insulation; heat loss from bare pipes.

STEAM POWER PLANTS

High-Pressure. Generation and Utilization of High Pressure Steam in the Florisdorf Loeffler Plant (Erzeugung und Verwertung von Hoechstdruckdampf. Die Floridsdorfer Loeffler-Anlage), A. Demmer. Zeit. des Oesterreichischen Ingenieur und Architekten Vereines (Vienna), vol. 81, no. $^3/_4$, Jan. 18, 1929, pp. 19–23, 9 figs. Merits of Loeffler high-pressure process; details of boilers, economics of generating steam of 140 atmos. pressure, 480 deg. cent. at rate of 12 tons; high-pressure steam power plants.

Industrial. Progress in the Art of Steam Generator Grows Out of Operating Experience at Staley Plant, G. F. Klein. Power, vol. 69, no. 11, Mar. 12, 1929, pp. 424–428, 5 figs. Account of gradual additions and improvements to steam generating equipment at Decatur, Ill., plant of large manufacturer of corn products; recently it was decided to install three more large pulverized-fuel units and convert to pulverized coal present two 8970-sq. ft. stoker-fired boilers; at 400 per cent of normal rating boiler is designed to deliver continuously 100,000 lb. of steam per hour; burner and mill arrangement was designed so that unit of each type could be used under same boiler and at same time.

Wage-Payment Plans. Increased Efficiency Meets the Pay-Roll, M. J. Hess. Factory and Indus. Mgmt., vol. 17, no. 2, Feb. 1929, pp. 264–

266, 6 figs. Description of procedure of wage-incentive plan in boiler room at plant of T. M. Sinclair and Co., meat packers of Cedar Rapids, Ia.

STEAM TURBINES

Back-Pressure. Use of Back-Pressure Turbines in Industrial Plants Utilizing Steam for Heating Purposes (Emploi des turbines à contre-pression dans les industries utilisant la vapeur pour le chauffage), P. Bregeon. Chaleur et Industrie (Paris), vol. 9, no. 103, Nov. 1928, pp. 666–668. Advantages of back-pressure turbines are set forth; direct control of machines by back-pressure turbines; use of boilers of very high pressure and of heating apparatus of as low pressure as possible is recommended.

Corrosion in. Relation Between Corrosion of Superheaters and Incrustation of Turbine Blades (Les relations entre la corrosion des surchauffeurs et l'incrustation des ailettes de turbines), C. Roszak and M. Pillet. Chaleur et Industrie (Paris), vol. 9, no. 103, Nov. 1928, pp. 647–650 and (discussion) 651–652. Problems arising with use of high-pressure steam are discussed; deposits on turbine blades; influence of chlorides; examples are cited.

Design. Tendencies in Steam Turbine Development, H. L. Guy. Engineer (Lond.), vol. 147, nos. 3812 and 3813, Feb. 1 and 8, 1929, pp. 136–138 and 152–155, 10 figs. See also Engineering (Lond.), vol. 127, nos. 3290 and 3291, Feb. 1 and 8, pp. 148–151 and (discussion) 163–164, and 183–186, 10 figs. Thermal advantages gained by adoption of increased pressures are illustrated; number of turbine cylinders into which total expansion and steam flow is divided varies between extremes of single cylinder to five cylinders; resuperheaters effect of elevated temperatures on properties of materials; regenerative feed heating or bleeder heating. Paper before Instn. Mech. Engrs.

Multi-Stage. Multi-Stage Steam Turbine (Les turbines à vapeur à soutirage multiple), Lamouche. Chaleur et Industrie (Paris), vol. 9, no. 103, Nov. 1928, pp. 653–665, 14 figs. partly on supp. plate. Study of production of mechanical energy by heating steam; different types of turbines are described; regulation of double-stage turbine; case of several absorption stages; multi-stage turbine is explained as one capable of discharging variable quantities of steam intended generally for heating of industrial apparatus.

Steam Regeneration. Design and Function of Turbines With Regenerative Feed Heating (Note sur la détermination et le fonctionnement des turbines a récupération de vapeur), C. Colombia. Chaleur et Industrie (Paris), vol. 9, no. 103, Nov. 1928, pp. 669–682, 23 figs. General case of turbine with steam regenerator is discussed; comparison between regenerator installation and installation with direct drive; example of use of back-pressure turbine.

Vibration. Vibrations of Circular Plates and Rings (Studien ueber Schwingungen von Kreisplatten und Ringen), W. Hort. Schweizerische Bauzeitung (Zurich), vol. 92, nos. 23 and 25, Dec. 8 and 22, 1928, pp. 285–288 and 315–317, 22 figs. Review of experimental research on subject; theory of period frequency, etc., of transverse vibrations in circular plates having hole in center; experimental verification of theory making use of Chladni's figures; bearing of theory on turbine design.

STEEL

Alloy. See ALLOY STEELS.

Chrome-Nickel. See CHROMIUM-NICKEL STEEL.

Die. See DIES, Steels for.

High-Speed. See HIGH-SPEED STEEL.

Rimmed. Physical Chemistry of Rimmed Steel, J. E. Carlin. Blast Furnace and Steel Plant, vol. 17, no. 2, Feb. 1929, pp. 261–262. Terms rimmed, open, and effervescent, are applied to low carbon steels manufactured by basic open-hearth and Bessemer processes to which little deoxidation is applied with exception of manganese, either in furnace, ladle, or molds; phenomena manifest in solidification of ingots are explained in theory; practice of producing rimming steel is outlined; physical chemistry of process.

Tempering. Effect of Tempering on the Mechanical Properties of Steel, J. Orland. Fuels and Furnaces, vol. 7, no. 2, Feb. 1929, pp. 217–218. On tempering quenched steel, finely granular pearlite is obtained, giving tensile strength and impact resistance greater than that given by laminar pearlite in annealed steel; for low-carbon steel, 500 deg. cent. appears best; for higher carbon, 580 deg. has yielded good results. Abstract of paper presented before Iron and Steel Inst.

Testing, Mechanical. Recent Mechanical Tests of Steel at Higher Temperatures (Neuere mechanische Pruefungen von Stahl in der Waerme). A. Pomp. Jernkontorets Annaler (Stockholm), vol. 111, June 2, 1928, pp. 44–66, 25 figs. Review of recent experimental studies of mechanical strength of steel, at temperatures up to 100 deg. cent., made by Mellanby and Kerr, Oertel, French and Tucker, Koerber and Pomp, Dickenson and others; details of special apparatus used. (In German.)

STEEL CASTINGS

Heat Treatment. Recommended Heat Treatment Practice for Carbon Steel Castings. Foundry, vol. 57, nos. 3 and 4, Feb. 1 and 15, 1929-supp. plates nos. 752 and 753. Feb. 1: Recommended practice in regard to annealing; variation of temperature with carbon content when treating above upper critical point is described; use of pyrometers; reheating process. Feb. 15: Recommended practice in regard to normalizing, normalizing followed by reheating, and quenching followed by reheating. From Am. Soc. Testing Materials Standards, 1927.

STOKERS

Traveling-Grate. Development of Traveling Grates (Entwicklung der Wanderroste), J. H. Nissen. Waerme (Berlin), vol. 52, no. 4, Jan. 26, 1929, pp. 66–67, 1 fig. Results are now being obtained with traveling grates which compare favorably to underfeed furnaces, and can therefore be employed in large boilers; among advantages are comparatively low cost of installation and maintenance; Nyeboe and Nissen system of self-cleaning grate with automatic removal of dropping coal is described.

T

TRAIN CONTROL

Automatic. First Principles of Automatic Train Control, V. T. Kropid. Ry. Elec. Engr., vol. 19, no. 1, Jan. 1928, pp. 16–21, 15 figs. Instructive information designed to interest those who are breaking into this new and important branch of electrical work; analysis of testing instruments; calibrating equipment; emission test of vacuum tubes.

Cab Signaling. Pennsylvania Installs Code System of Train Stop With Signaling. Ry. Age, vol. 84, no. 2, Jan. 14, 1928, pp. 139–142, 4 figs. Four-indication cab signals, power immune from foreign current and position-light signals included in installation on 1492 track-miles; code system brought out in 1926; features of wayside equipment; engine equipment; general description of operation; locomotive circuits and pneumatic equipment; 100-cycle power-distributing system.

Santa Fe Employs Cab Signaling Exclusively With Train Control, R. E. Liston and G. K. Thomas. Ry. Elec. Engr., vol. 19, no. 1, Jan. 1928, pp. 3–8, 8 figs. System installed by U. S. & S. Co. on Illinois Division, 175 miles of double track on A.T.&S.F.R.R.; speeds controlled by cab signals; description of control engine equipment and its maintenance; Union continuous inductive system is used with speed-control equipment box mounted on top of boiler.

V

VALVES

Steam, High-Pressure. Modern Types of Valves for High Pressures, G. H. Pearson. Mech. World (Manchester), vol. 85, nos. 2192 and 2195, Jan. 4 and 25, 1929, pp. 3–5 and 71–73, 8 figs. Jan. 4: More important developments or modifications from previous designs made imperative by upward trend of steam pressures and temperatures are described; valves suitable for working steam pressure up to 500 lb. per sq. in. and superheated steam up to 800 deg. fahr.; junction valve; glove stop valve. Jan. 25: Design and construction of parallel side valves, and safety valves are discussed.

W

WAGES

Incentive Payment Plans. Wage Incentives Increase Production, F. W. Corley. Mfg. Industries, vol. 17, no. 2, Feb. 1929, pp. 99–102, 33 figs. New plan works with unusual success under manufacturing program involving both machine and hand work; value of records; system benefits both workers and company; Manit (standard man-minute of work) system guarantees certainty of work.

WEIGHING MACHINES

Automatic. Automatic Weighing Machines. Engineer (Lond.), vol. 147, nos. 3811–3812 and 3813, Jan. 25, Feb. 1 and 8, 1929, pp. 90–92, 120–122 and 148–150, 18 figs. Jan. 25: New series of automatic weighers made by Henry Simon, Ltd., of Manchester, are described; features of problems involved in design of such machines; testing for balance. Feb. 1: Compensating device; residue weighing; hopper-feed control; discharge control. Feb. 8: Mechanically fed weigher for sluggish materials; automatic blending control.

WELDING

Electric. See ELECTRIC WELDING, ARC.

Oxyacetylene. See OXYACETYLENE WELDING.

WOOD PRESERVATION

Experiments in. Experiments in Wood Preservation, L. P. Curtin and W. Thordarson. Indus. and Eng. Chem., vol. 20, no. 1, Jan. 1928, pp. 28–30. Toxicity data not previously reported are given, also table showing "killing points" of various inorganic preservatives experimented with; 12 additional fungi have been studied; toxicity of zinc meta-arsenite in powder form toward 14 wood-rotting fungi has also been studied.

New Methods. New Methods for the Preservation of Wood [Die Konservierung (Impraegnierung—Imfung) des Holzes nach neuen Methoden], H. Arndt. Kunststoffe (Munich), vol. 18, no. 9, Sept. 1928, pp. 200–202. Brief account of value of various preservatives for wood exposed to atmospheric action, as demonstrated by Forest Products Research Laboratory in U. S. Department of Agriculture; for dry rot in houses proprietary disinfectant is recommended; instances are quoted in which this disinfectant has effectively preserved wood exposed to damp; methods of use, i.e., application, soaking and spraying, are described.

WOOD WASTE

Pneumatic Handling of. Pneumatic Conveying of Wood Shavings (Spaeneabsauge- und Transportanlagen), R. Karg. Maschinen-Konstrukteur (Leipzig), vol. 61, no. 23, Dec. 1, 1928, pp. 553–556. General discussion of conveying of sawdust and shavings by means of exhaustors; principles of design of suction systems for this purpose.

Use as Fuel. Burning Hog Fuel in the Pacific Northwest, O. L. LeFever. Power, vol. 67, no. 6, Feb. 7, 1928, pp. 248–249, 2 figs. Discusses its possibilities and limitations and some of requirements for successful burning for power generation; burning hog fuel in Dutch oven; transportation of hog fuel limited to 100 miles; sturdy conveyors needed for handling hog fuel.

WOODWORKING

Research. Results of Recent Woodworking Research (Neuere Forschungsergebnisse auf dem Gebiete der Holzbearbeitung), E. Sachsenberg. Maschinenbau (Berlin), vol. 7, no. 23, Dec. 6, 1928, pp. 1094–1104, 27 figs. Report on experimental research at Dresden Institute of Technology.

WOOLEN MILLS

Reconstruction. Important Enlargements and Improvements Made by New England Woolen Mills. Textile Wld., vol. 73, no. 5, Feb. 4, 1928, pp. 381–382, 3 figs. Describes how old cotton mills have been reconstructed for use as woolen mills and what machinery was installed to bring mills up to date and lessen cost of production.

WROUGHT IRON

Aston Process of Manufacture. Wrought Iron Made by a New Process, C. Longenecker. Blast Furnace and Steel Plant, vol. 17, no. 2, Feb. 1929, pp. 263–265, 4 figs. A. M. Byers Co., Warren, O., have developed method of manufacture which produces pure wrought iron of very high quality; reaction necessary to process; method of mixing iron and slag in large quantities and exceedingly intimately by forming fine shot from molten iron, and then dropping shot into cold liquid slag; resulting globule contained hollow center; indicated that gas was formed in shot where it was suddenly cooled, but that gas could not escape through chilled shell; steps in process; shotting iron.

IN TWO SECTIONS—SECTION TWO

MECHANICAL ENGINEERING

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What It's All About

THE literature of engineering societies and of the technical press is filled with important contributions of great value to industry. Unfortunately, engineering, like science, is not simple and cannot be disassociated from technical treatment. But it is possible to call attention to engineering progress and to emphasize its significance in such a way that non-technical men may sense its value and busy men may know "what it's all about."

This supplement to MECHANICAL ENGINEERING is conceived in the spirit of rendering a service of interpretation to its readers. After you have read this single sheet, pass it on to some one who may be interested in the engineering progress which is outlined in these few paragraphs.

The American E.M.F.

THE engines of war are as ancient as history. Troy fell before their superhuman effectiveness, and the first engineers were, like Archimedes, employed in military activities. Our present-day term "civil engineer" was originally applied to distinguish the constructive engineer of peace times from the military engineer. Today, every member of the A.S.M.E. is a member of its National Defense Division, through whose efforts it is possible to present as the leading article in MECHANICAL ENGINEERING for May an authoritative statement on mechanization in the army.

It was the tank which formed the basis of the American E.M.F., the experimental mechanized force which was organized in 1927 following a study made by the War Department General Staff. With a total force of 1200 men and 400 vehicles of all kinds, and assembled at Fort Leonard Wood in the summer of 1928, the E.M.F. undertook a series of maneuvers and experiments. The basic elements of a mechanized force are tanks, airplanes, gas, and artillery. The first three are products of the World War. The last was the Napoleonic contribution.

Guarding Against Obsolescence

IN THE May issue of MECHANICAL ENGINEERING, Harold V. Coes writes on "Taking Care of Depreciation and Obsolescence." He defines many terms such as decrepitude, supersession, inadequacy, obsolescence, and wear and tear, and shows how difficult it is to forecast an accurate rate of depreciation. The causes of obsolescence seem to be functions of progress, and frequently may be attributed to the engineer whose activities have produced the new machine, material, or process. Mr. Coes proposes two sound ways of dealing with obsolescence. One is to set aside from surplus an obsolescence fund. The other is a proposed form of insurance for obsolescence, to be worked out in cooperation with insurance underwriters.

Rochester, N. Y., May 13 to 16

THIS place and data connote the coming meeting of the A.S.M.E. A program of 15 technical sessions at which 33 papers will be read, with numerous committee meetings, excursions, luncheons, and dinners such as appertain to an engineering convention, will be sufficient inducement to attract a thousand engineers to Rochester.

Following a policy of many years' standing, extensive abstracts of some of the papers to be presented at Rochester appear in the May issue of MECHANICAL ENGINEERING. The program of the meeting and a very brief description of every paper will be found on pages 401–406. Attendance at the sessions and participation in the discussion should prove to be a stimulating experience. An order blank to be found on page 406 may be used in requesting copies of the papers which have been preprinted.

Pneumatic Transmission

THOSE little cylindrical change carriers which pop out of pipes in department stores have many more uses than you might think of at first, and their history runs back further into the past than is generally known. James Whiting, who writes on "Handling Papers and Small Articles by Pneumatic Tubes," finds a record of a proposed pneumatic transmission as far back as 1667.

It seems that in steel mills ingot test pieces are transported in heat-insulated carriers between the various mill departments and the laboratory; that in railway freight classification yards there are pneumatic-tube lines varying in length from 1000 to 6000 ft.; and that in insurance offices and banks and commercial houses where important papers must be sent from one place to another, messenger service is greatly expedited by these burrowing travelers which accomplish for papers and small articles what the telephone does for conversation. Mr. Whiting's paper will be read at Rochester.

Heat Transmission and Insulation

SO MANY persons are interested in research in heat transmission and the subject is such an important one that the National Research Council has established a committee on heat transmission to coordinate the efforts of the individual researchers and serve the need which industry has for more accurate and readily available information in this field.

In MECHANICAL ENGINEERING for May, W. V. A. Kemp, director of the committee, explains its purpose and organization and gives a list of the educational institutions in the United States in which work is at present in progress and the subjects which are under investigation. Any one contemplating researches in heat transmission or desiring information in this field should look to the committee as a clearing house.

Specific contributions to our knowledge of the flow of heat are made this month by L. B. McMillan, whose paper for the Rochester meeting of the A.S.M.E., entitled "Heat-Insulation Practice in the Modern Steam-Generating Plant," appears in abridged form in MECHANICAL ENGINEERING for May, and by R. H. Heilman, whose "Surface Heat Transmission," also for presentation at Rochester, is similarly treated.

Cutting With Diamonds

DIAMOND tools are used where the material to be cut is too hard for a steel tool or where greater accuracy or better finish is wanted than can be obtained when using steel tools. The diamond used is the discolored and faulty single crystal of carbon, not suitable for jewels, commonly known as bort.

In the May issue of MECHANICAL ENGINEERING, C. L. Bausch, in a paper entitled "Diamonds as Metal Cutters," submits data regarding the selection and setting of diamonds for cutting tools, cutting speeds and feeds, tool life, and limitations due to vibration. The paper is to be presented and discussed at Rochester.

Lumber Conservation and Wage Payment

IN A PAPER on "Conservation of Lumber in Woodworking Plants," in the May issue of MECHANICAL ENGINEERING, Carle M. Bigelow describes a method for the installation of a differential group wage-payment plan for the cutting departments of woodworking plants. The group is paid on a basis of reduction in per cent of wastage of lumber intake and increase in production of board feet per man-hour. The paper is to be read at the Rochester meeting of the A.S.M.E. and is greatly abridged in its present form. The complete paper, which may be had upon request, gives the necessary details for accumulation of data for the installation of the method described.

Boiler-Water Treatment

SO IMPORTANT is the subject of boiler-water treatment that a joint committee of several engineering societies, including the A.S.M.E., has been established with nine sub-committees devoted to various phases of the problem. A fund of $300,000 to cover the cost of an extensive research is being raised. Numerous reports and special articles have been prepared and read before meetings of the societies sponsoring the project.

As one of the contributions of the committee, Frederick G. Straub, of the Engineering Experiment Station, University of Illinois, presents a paper on "Control of Boiler-Water Treatment to Prevent Embrittlement," at the Rochester meeting of the A.S.M.E. The paper is published in the May issue of MECHANICAL ENGINEERING.

Boiler-Furnace Refractories

ONE of the important researches sponsored by the A.S.M.E. is on boiler-furnace refractories. C. F. Hirshfeld, chairman of the special research committee, presents a résumé of the purpose and accomplishments of his committee in the May issue of MECHANICAL ENGINEERING.

At the meeting of the Society in Rochester there will be presented a symposium of six papers on various phases of the committee's work. Mr. Hirshfeld outlines these papers briefly. The complete papers are obtainable upon request.

A Glance at the "Survey"

KEEPING up with engineering and technical literature is a difficult task. The A.S.M.E. provides two time-saving methods. The Engineering Index Service, which covers a group of 1700 engineering and scientific journals in 17 languages, is combed every month for items of special interest to mechanical engineers. These are printed in the text pages of the Society's journal, MECHANICAL ENGINEERING.

In addition to these short items, twelve pages of more extensive abstracts are published in the "Survey of Engineering Progress" in the same journal. The brief condensations of these abstracts which follow indicate the variety of the subjects treated. Reference to the Survey Section will yield not only the abstract but the source of the original article.

Some information concerning the Fairey long-range monoplane which has a wing span of 82 ft., a total wing area of 902 sq. ft., and carries 1000 gal. of gasoline in its wings has been released by the British Air Ministry.

At a recent dinner of the Royal Aeronautical Society, the subject of crude oil or gasoline for aeronautical engines was discussed by several experts.

The history of the Reynolds Tube Co., Ltd., at Tyseley-near-Birmingham is presented, and some of the methods used in the manufacture of metal tubing for aircraft are described.

A machine for testing the lashing wire used for holding the blades of steam turbines has been installed at the South Philadelphia Works of the Westinghouse Electric and Manufacturing Company.

A description, with reports of tests, is given of a new type of two-stroke, double-piston, internal-combustion engine known as the "Bro-Hawk."

The author of an article on the fineness of pulverized coal questions whether the demand for high percentages to go through a 200-mesh screen is justified.

The Deguingand two-stroke-cycle internal-combustion engine has four cylinders but only two combustion chambers.

John E. Hess of Westminster, B. C., has invented a "helioplane" which is claimed to rise vertically from the ground.

The Einstein process for metallizing non-conducting materials employs a preparation which, when applied to the surface of any material, renders that surface electrically conductive so that metals can be deposited as in ordinary electroplating.

A new boiler-room instrument combines the Shakespeare katharometer used as a CO_2 meter with a Cambridge electrical CO_2 indicator and recorder, the meter being combined with a bubbler aspirator in one complete all-metal unit.

The Société Alsacienne de Constructions Mécaniques has made interesting improvements in the Atmos boiler, which is of the rotating type.

The cross-license patent agreement of December 31, 1928, for the purpose of preventing patent litigation in the aircraft industry which might retard the production of aircraft for the national defense is explained by Lt-Col. Joseph I. Miller, Judge Advocate General's Department, in charge of war department patents.

The inventor of the device describes a machine for making ice flakes on a revolving drum.

Sulphide segregation in steel is described as rendering the steel unsatisfactory for use and as being a common cause for most elusive troubles experienced by all engineers.

The new British Mercedes-Benz six-wheel 10-ton truck is equipped with an 80-hp. Diesel engine.

Research on the structure of rubber by means of the X-ray is reported.

David Brownlie reports the progress during 1928 in the use of pulverized fuel for steam raising in Great Britain.

There are described methods of carbureting and storing the gas used as fuel for internal-combustion engines on Paris buses.

In a discussion of the general subject of fatigue strength of steel, the author brings out as one of the results of practical importance the fact that a material stronger in tension may be more likely to fail under certain stresses resulting in fatigue.